ENERGY STAR®
Data Center Rating Development Meeting

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December 18, 2007
Web Conference

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Today's Agenda

- Welcome & Goals of the Meeting
- Introduction
  - EPA ENERGY STAR Data Center Initiative – Alexandra Sullivan, EPA
  - DOE Save Energy Now – Paul Scheihing, DOE
- Developing the ENERGY STAR Rating for Data Centers – William Angle, CSTechnology
  - Basis for ENERGY STAR Rating
  - Key Operational Differences in Data Centers
  - Data Elements Needed to Assess Differences and Build a Rating
- Next Steps & Proposed Timeline

Goals of the Meeting

- Share information on EPA's and DOE's plans to support energy efficiency in data centers
- Solicit feedback for identifying and defining data elements needed to develop an energy performance rating
- Provide an overview on the rating development process

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Introduction

- Data center energy use is rapidly increasing
  - 61 billion kWh in 2006 (1.5% of US electricity)
  - Projected to be 100 billion kWh by 2011
- Complex energy questions
  - Different configurations of equipment
  - Various types of output & processing required
  - Multiple power supply and cooling options
- Extremely dynamic industry
  - Challenge to develop metrics
  - Best metrics may change as technologies change

Energy Performance Rating Goals

- Benchmark and profile data center energy use
- Compare similar data centers
- Track energy use over time and measure improvement in energy performance

Energy Performance Rating Goals

- Ideal high level metric: useful work / kw-hr
- Challenge: how to measure “useful work” - teraflop or other alternative
- Next Steps to meet metric goals
  - Agree on “useful work” – challenge industry to reach consensus
  - Implement working metrics for end users – can begin with IT load / Total load ***(focus of today’s discussion)***

EPA ENERGY STAR for Commercial Buildings – Overview

- Energy management program that provides proven solutions to help building owners and managers reduce their energy consumption
  - Help businesses protect the environment through superior energy performance
- Numerous tools & technical resources
  - National rating system for buildings to benchmark and track energy use
  - Energy management guidelines
  - Advice on design for energy efficient buildings
  - Online case studies and best practices
  - Calculators to track return on energy efficiency investments
  - Training
- Opportunities for national recognition

EPA ENERGY STAR for Commercial Buildings – Overview

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- Work in markets with a focus on:
  - Commercial Property (offices, retail, hotels)
  - Public Sector (government, education)
  - Healthcare
  - Small businesses and congregations
- Provide an online tool to rate energy performance on a scale of 1-to-100
  - Over 60,000 buildings have been rated
- Buildings that earn a 75 or higher can earn the prestigious ENERGY STAR label
  - Over 4,000 buildings have earned the ENERGY STAR
- Learn more: **www.energystar.gov/buildings**

EPA ENERGY STAR for Commercial Buildings – Rating System

- Convey information about energy performance in a simple metric that can be understood by all levels of the organization

Is 10 MPG high or low for an automobile?

Is 90 kBtu/SF/YR high or low for an office building?

Fuel Efficiency

MPG

Energy Efficiency Rating

1 - 100

EPA ENERGY STAR for Commercial Buildings – Rating System

- Monitor actual as-billed energy data
- Create a whole building indicator
  - Capture the interactions of building systems not individual equipment efficiency
  - Track energy use accounting for weather and operational changes over time
- Allow for peer group comparison
  - Compare a building's energy performance to its national peer group
  - Track how changes at the building level alter the building's standing relative to its peer group

EPA ENERGY STAR for Commercial Buildings – Data Centers

- Partnerships with large end-users
  - Banking, financial services, insurance, internet commerce
- Partners operate stand alone data centers and data centers in larger office buildings
- Energy use in data centers is increasingly important to partners
- Goals
  - Develop rating for stand alone data centers
  - Incorporate data centers into building ratings
- Needs
  - Monitored data on energy use in data centers
  - Ability for metrics to handle change

EPA ENERGY STAR for Commercial Buildings – Data Centers

- Next Steps
  - Discuss proposed data elements for collection
    - ***In progress, focus of today's meeting***
  - Develop template and conduct survey for data
    - ***2008, we need your help!***
  - Analyze data an develop working metric
  - Incorporate results into Portfolio Manager
- Coordination with DOE
  - Share data and lessons learned during data collection efforts
  - Enable Portfolio Manager and DOE's Software Tool Suite to share data, performance metrics, and recommendations

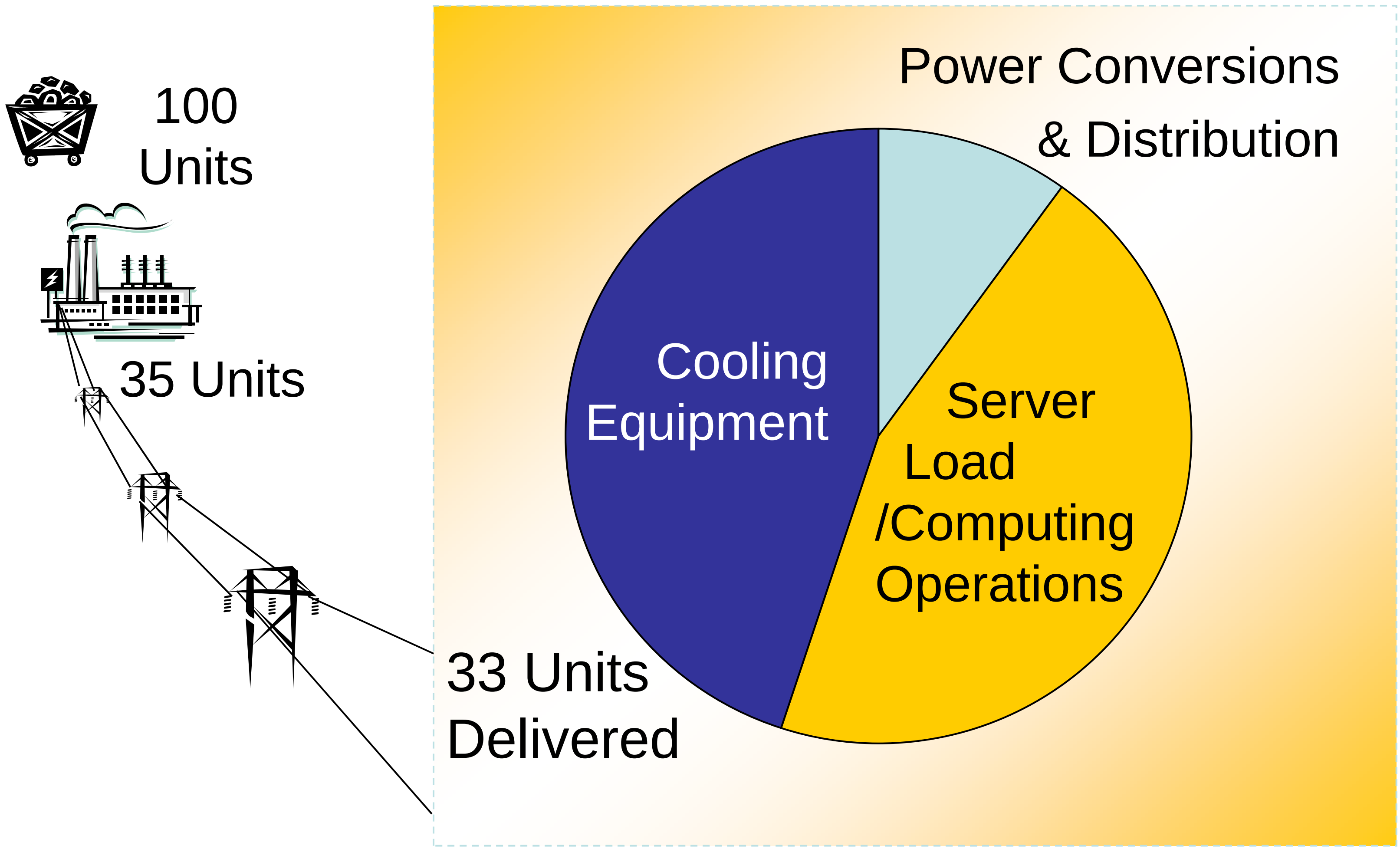
Save ENERGY Now

DOE Data Center Energy Efficiency Program

Paul Scheihing
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Industrial Technologies Program

December 18, 2007

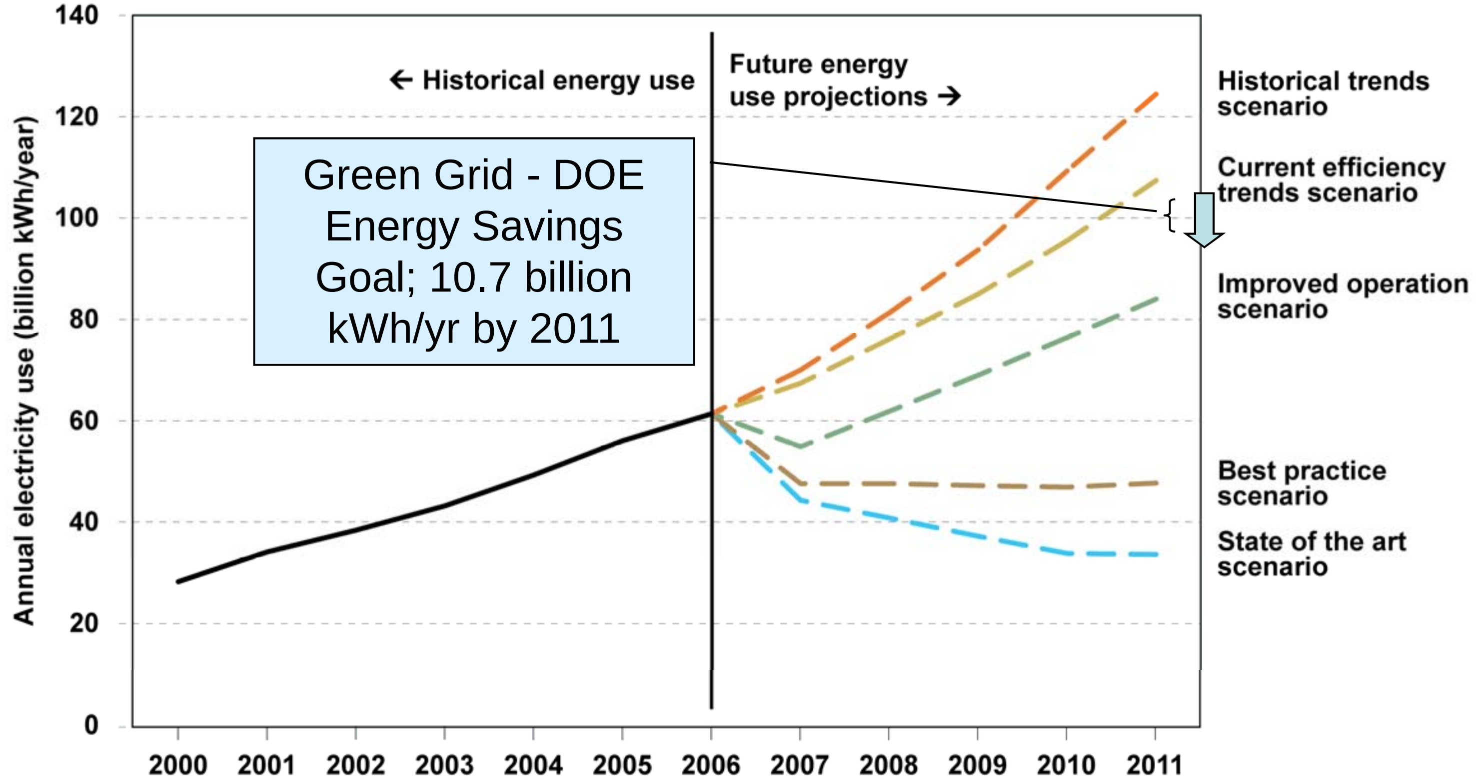
Typical Data Center Energy End Use



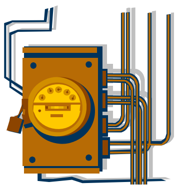
DOE-Green Grid Goal for Energy Savings

Goal is 10% overall US data center energy savings by 2011

- 10.7 billion kWh
- Equivalent to electricity consumed by 1 million typical U.S. households
- Reduces greenhouse gas emissions by 6.5 million metrics tons of CO_2 per year



Vision for Energy Efficiency in Data Centers



1. Create tools and guidelines to drive continuous improvement
2. Establish metrics for overall data center energy intensity
   - IT and infrastructure
   - Energy cost ($), source energy (Btu), and carbon emissions (M tons)
   - Specified Best-in-Class targets for various types of data centers

3. Support third-party certification process to validate energy intensity improvement and Best-in-Class
4. Provide recognition for data centers that achieve a certain level of energy savings

Save Energy Now: Products & Services

Tools

- Process Heating
- Steam Systems
- Plant Energy Profiler
- Motors & Pumps
- Fans

Information

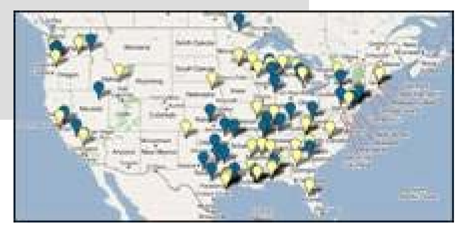
- Website
- Information Center
- Tip Sheets
- Case studies
- Webcasts

Training

- Basic
- Advanced
- Qualified Specialist

Assessments

- Energy Savings Assessments
- Industrial Assessment Centers



450 Save Energy Now Assessments Were Completed Across United States in 2006 and 2007

DOE Save Energy Now Data Center Program

Major Program Elements

1. Develop Software Tool Suite
2. Create consensus metrics
3. Create and publicize Save Energy Now case studies through performing pilot energy assessments
4. Create best practice information and a training curriculum
5. Develop Qualified Specialists program for Data Centers
6. Create guidelines for "Best-in-Class" data center in various classes of data centers, including strategies for incorporating distributed generation technologies

Industrial Technologies Program

- Tool suite & metrics
- Energy baselining
- Training
- Qualified specialists
- Case studies
- Certification of continual improvement
- Recognition of high energy savers
- Best practice information
- Best-in-Class guidelines

Save ENERGY Now

Federal Energy Management Program

FEMP

- Best practices showcased at Federal data centers
- Pilot adoption of Best-in-Class guidelines at Federal data centers
- Adoption of to-be-developed industry standard for Best-in-Class at newly constructed Federal data centers

EPA

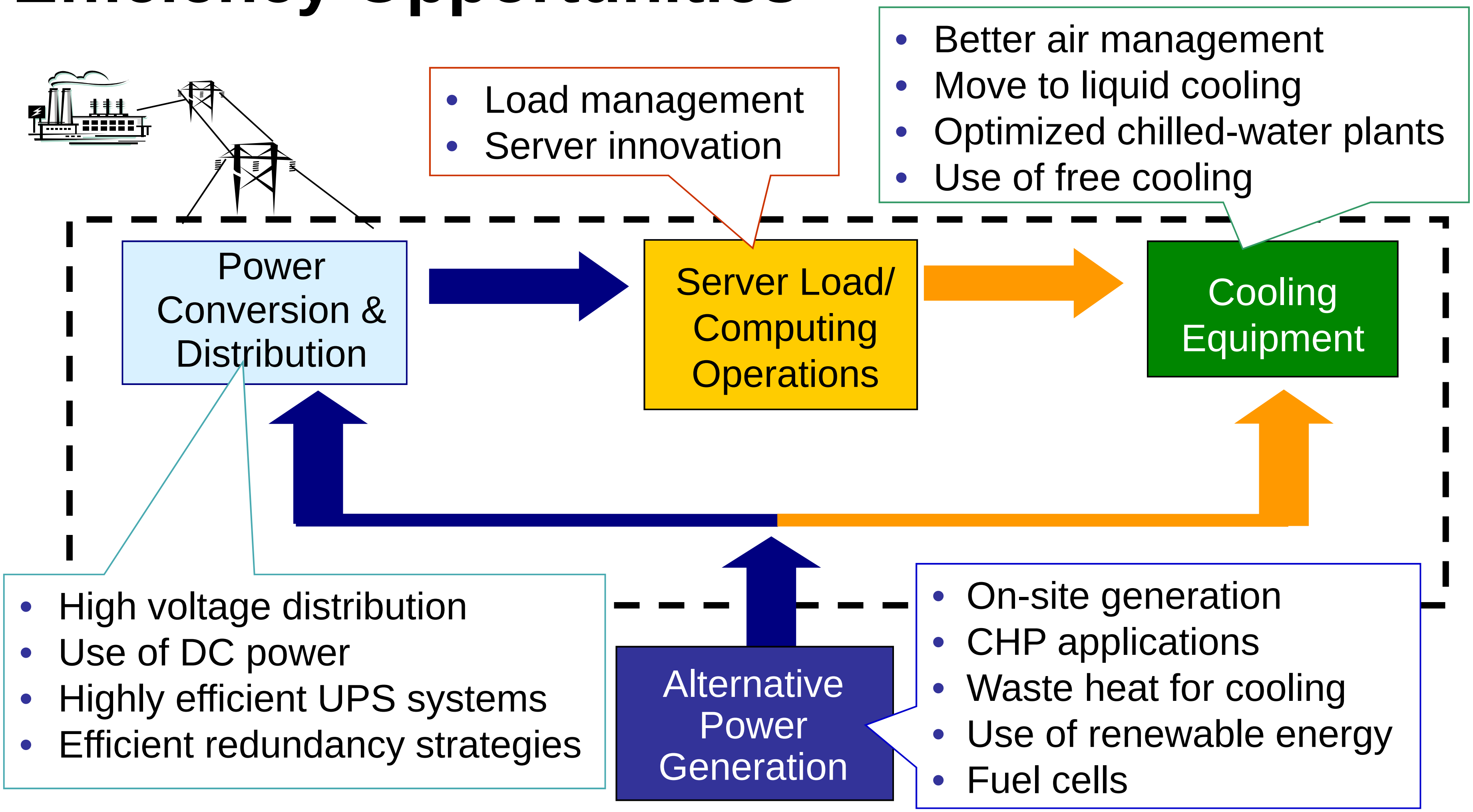
- Metrics
- Server performance rating & ENERGY STAR label
- Data center performance benchmarking

Industry

- Tools
- Metrics
- Training
- Best practice information
- Best-in-Class guidelines
- IT work productivity standard

Information Technology Industry Council
Uptime Institute
AFCOM
7X24 Exchange
Silicon Valley Leadership Group
Critical Facilities Roundtable

Tools and Metrics Help to Find Energy Efficiency Opportunities

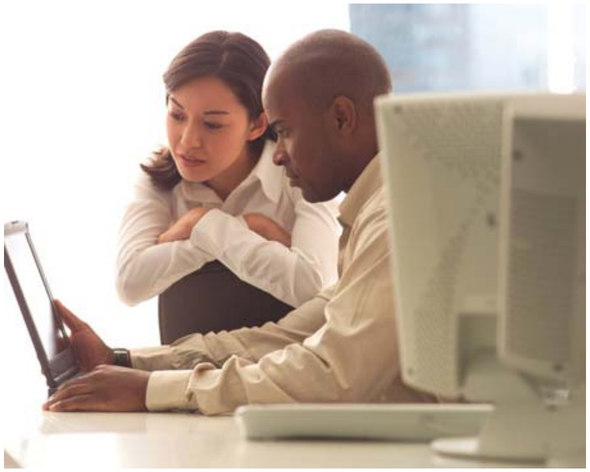


Develop Software Tool Suite

Save ENERGY Now

Tools to define baseline energy use of data center and identify key energy-saving opportunities

- Determine general performance of the data center
- Benchmark subsystems
- Assess energy savings potential
- Track energy intensity improvement
- Provide quantification of key metrics including cost ($), primary energy (Btu), and carbon



Develop Data Center Software Tool Suite with initial set of Metrics by August, 2008

Hold industry tool and metrics workshop

Complete 10 pilot assessments to test the Tool Suite and Metrics,

Release beta version

Complete beta testing and release Version 1.0

Q4 2007	Q1 2008	Q2 2008	Q3 2008

12/18/2007

04/01/2008

08/01/2008

Projected Timeline

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Basis for the ENERGY STAR Rating

We Need A Standard

(What is an energy efficient Data Center?)

– How have we defined reliability?
  – Benchmarked Designs (1992)
  – Captured real reliability data (Uptime Institute and others)
  – Developed “Tier Levels” (I, II, III, IV)
  – Industry adopted the use for reliability definition
  – Standard does not reflect all factors (Infrastructure only)
  – Adjustments have been made to “mature” standard

- NOW Transfer the process to an energy efficiency Standard
  - Similar to current EPA benchmarks (Buildings, Retail, etc)
  - Timeframe to develop: Approximately One Year

The Ultimate Standard

“IT load” and “Total Load”

A Test for an Efficiency standard

– The ratio work for all data centers of any size range, mission applicability, infrastructure redundancy, location, supply voltage, energy density or other use factors compared with the total energy input for the process.

Basis for the ENERGY STAR Rating

“IT load” and “Total Load” Efficiency Rating

- How do we define?
  - Predictable and intuitive
  - Non – geocentric
  - Repeatedly measurable
  - Quantifiable (reduced to an Index Value 0 to 100)
  - Generic
    - Equipment types
    - Technology
    - Vendors
    - Users
    - Non Disruptive measurement
  - Ultimately - Not Just Infrastructure

Basis for the ENERGY STAR Rating

Measurement Process Issues

Where are measurements taken with respect to IT equipment, power supplies, UPS, etc.?

- **What is <u>THE</u> significant ratio with large amount of "Data Centers" commingled with office load**
- **How can vendors help with instrumentation?**
- **How is it repeatable on a periodic basis without risk / high cost?**
- **How can "anybody" do it?**

Key Operational Differences in Data Centers / Office Buildings

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- **Increasingly strident calls for** Green **in the data center**
- **Focused reduction of Op-x (along with reduction of Cap-x)**
- **LEED designation for the DC helps define the creation of the asset – but does not measure on-going operational activity**
- **The reality of virtualization and IT Technology Improvements**
  - **A 50% reduction in the number of servers reduces power by only 25%**
  - **Increasing IT complexity fail-over and decreasing resiliency**
  - **Virtualization technologies disintermediate the hardware and business process**
- **Create increasingly complex data center fail-over operations**
- **Impact of outage will be more pervasive and less predictable**

Therefore energy savings may be overtaken by reliability issues

Issues with an Efficiency Rating

IT Load practical measurement does not adequately describe "IT Work"

- IT "Plug Load" has 25% Mechanical
- Processor Utilization is ignored
- Value in server consolidation and virtualization and not represented
- Energy-saving features are discounted
- Variability of IT work is ignored

Current measurement activities do not integrate throughout the Data Center Stack

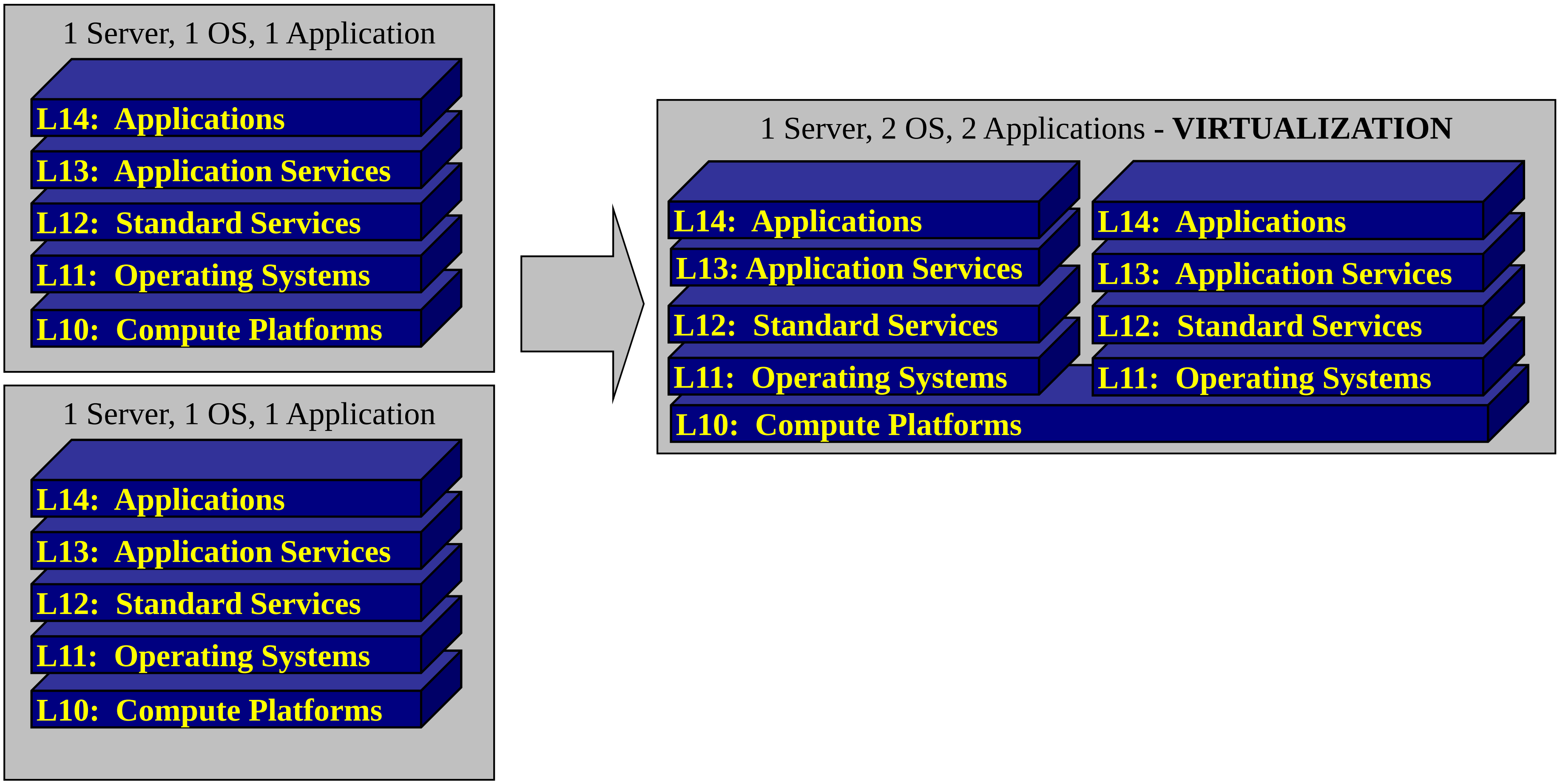
The Data Center Stack

L15: Business Processes	Trading, banking, manufacturing, petro-chemical
L14: Applications	Business Unit applications
L13: Application Services	RDBMS, WebLogic, WebSphere, MQ,
L12: Standard Services	DNS / Active Directory / LDAP / File services
L11: Operating Systems	z/OS, Solaris, Linux, Windows, AIX, HPUX, OS/400
L10: Compute Platforms	Mainframe, midrange, Sparc- and Intel-based servers
L09: Storage & Persistence	Mass storage arrays, DASD, physical and virtual tape
L08: Switch Infrastructure	Telephony, network, DWDM, SAN and M/F directors
L07: Non-electronic IT	Cabinetry, conveyance, cabling systems
L06: Physical IT Spaces	Physical room distribution, pod layout, IT segregation
L05: M&E Distribution	Distribution of electrical and heat rejection to IT
L04: M&E Supply	Gross electrical and heat rejection capacities
L03: Facility Architecture	Building or facility structure and architecture
L02: Utilities	Power, water, and transportation systems
L01: Real Estate	In-country location selection
L00: Global Geography	Global geo-political distribution

Data Center Industry Potential

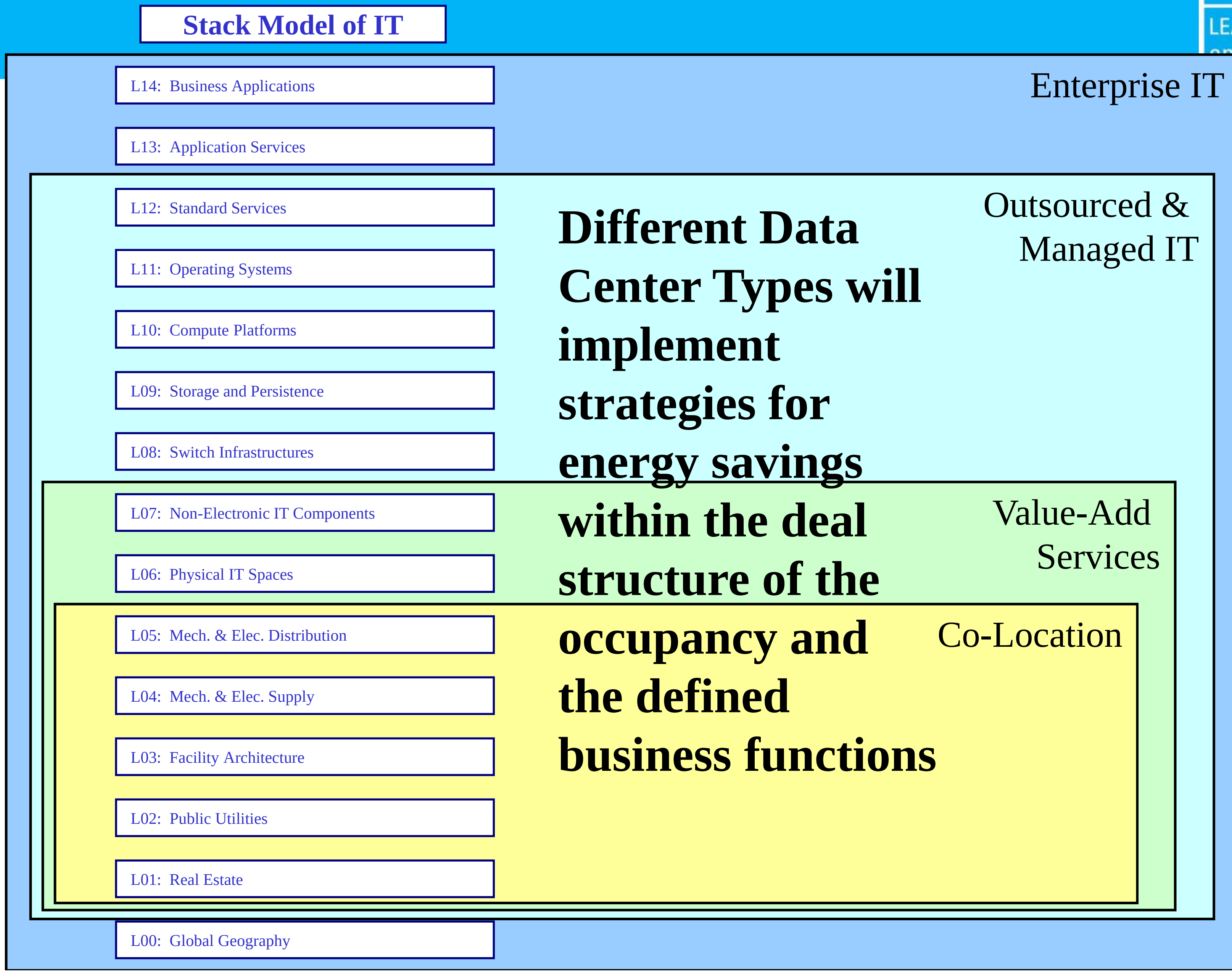
Description	Stack Model of Data Center	Stack Model of Desktop	
Business Unit applications	L14: Business Applications		
RDBMS, WebLogic, WebSphere, MQ,	L13: Application Services		
DNS / Active Directory / LDAP / File services	L12: Standard Services		
z/OS, Solaris, Linux, Windows, AIX, HPUX, OS/400	L11: Operating Systems	L11: Operating Systems	Optimization Opportunity
Mainframe, midrange, Sparc- and Intel-based servers	L10: Compute Platforms	L10: Compute Platforms	
Mass storage arrays, DASD, physical and virtual tape	L09: Storage and Persistence		
Telephony, network, DWDM, SAN and M/F directors	L08: Switch Infrastructures		
Cabinetry, conveyance, cabling systems	L07: Non-Electronic IT Components		
Physical room distribution, pod layout, IT segregation	L06: Physical IT Spaces		
Distribution of electrical and heat rejection to IT	L05: Mech. & Elec. Distribution		Common Services
Gross electrical and heat rejection capacities	L04: Mech. & Elec. Supply		
Building or facility structure and architecture	L03: Facility Architecture		
Power, water, and transportation systems	L02: Public Utilities		
In-country location selection	L01: Real Estate		

The Data Center Stack



Saves Energy and Increases Utilization (IT Work)

Industry Data Center Types



Issues with an Efficiency Rating

Summary:

Current Industry maturity will not allow common "IT Work" definitions

Application of Energy Saving Processes will effect portions of "IT Load"

Current measurement activities do not integrate throughout the Data Center Stack

Therefore What should be elements of the New EPA Data Center Rating?

Data Elements Needed to Assess Differences and Build a Rating

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Summary proposed data elements – (Santa Fe)

Operational Elements

- Energy Data = Total Energy (Load)
- Total IT Load
- Tier Level (Reliability)
- Climate Zone
- Type of Center
- Age of Facility
- Square Footage / Stand Alone Center vs. Within Larger Building
- % of Infrastructure Capacity
- % of IT Utilization (Average)

Data Elements Needed to Assess Differences and Build a Rating

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Element

Energy Data = Total Energy (Load)

Definition:

Annual Energy Consumption

(12 months utility data)

Issues:

- **Measured as a utility bill or sub-metered**
- **Not voltage dependant (15KV, 480, etc.)**
- **Will be input for one year initially and periodically afterward**

Data Elements Needed to Assess Differences and Build a Rating

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Element

Total IT Load

Definition:

PDU meter readings or as an alternate – UPS output meter

Issues:

- **Measured as a static or dynamic load (process)**
- **Measured "IT Plug" load**
- **Other Loads on UPS**
- **New Technology**

  (DC Power, Fuel Cell, Alternates)
- **Will be input for one year initially and periodically afterward**

Data Elements Needed to Assess Differences and Build a Rating

Element

Tier Level (Reliability)

Definition:

Tiers 1 – 4 Per Uptime Institute

The amount of required, active, redundant infrastructure adds efficiency losses to the system

Issues:

- **Is the "reliability" of the supply a factor in adjusting the energy index?**
- **Mechanical on UPS**
- **Redundant Utilities also contributes to less green activity**

Data Elements Needed to Assess Differences and Build a Rating

Element

Climate Zone

Definition:

Zip Code

Used for reference to inter-agency Weather Data for index calculation

Issues:

Is location important for:

- **Economizer effects?**
- **Building "skin" losses?**
- **Cost of energy transport?**
- **Cost of energy type?**
- **Water Availability?**

Data Elements Needed to Assess Differences and Build a Rating

Element

Type of Center

Definition:

Will the type of center* limit the capacity to use "higher order energy savings" techniques?

*Colos/ Financial/ Government/ Corporate/ Managed DR/ Telecom switches/ ISP routers/ Processing/ Data storage/ internet hosting

Issues:

- **Data Center Types have differing "deal" abilities to manage infrastructure**
- **"Batch" Processing centers can shift IT Load to Non-Peak periods**

Data Elements Needed to Assess Differences and Build a Rating

Element

Age of Center / Facility

Definition:

Will Infrastructure Age of Equipment and Building Enclosure Age have a significant Effect on Index Ratings?

Issues:

- **Older Data Center Equipment is not designed with efficient operation**
- **Older building envelop will not have LEEDs construction standards for roof and insulation**

Data Elements Needed to Assess Differences and Build a Rating

Element

Square Footage /

(Technical Equipment Area)

***Stand Alone Center vs. Within Larger Building**

Definition:

Will the size and/or *configuration of the technical area have ranges with significant differences between size categories?

Issues:

- **Raised Floor or non-raised floor?**
- **Include immediate infrastructure (PDU and AC) in Technical area?**
- **Enclosure Techniques**
- **Vertical Height (Volume)**
- **Stand-alone or connected data center to office central plant infrastructure**

Data Elements Needed to Assess Differences and Build a Rating

Element

% of Infrastructure Capacity

Definition:

What is the current IT load percentage of the total (redundant) infrastructure capacity?

Issues:

- **Will the extent of under-utilized (or planned / strategic additional infrastructure) be operating less efficiently and be a penalty in the index?**
- **Capacity at 80%, 85% or 90% is considered "fully loaded"**
- **Electrical and /or mechanical systems (i.e. VFD pumps) have "sweet-spots" for operation**

Data Elements Needed to Assess Differences and Build a Rating

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Element

% of IT Processor Utilization and Peak / Non-peak management

Definition:

What is the current IT processing load as a percentage of the total server processor capacity?

Issues:

- **A data center with effecient MEP systems and a 12% utilization in the IT process still "wastes" energy in useful "IT work"**
- **Efficient changes in technology do not get "credit" in the IT Load to Utility input ratio (PUE)**
- **Energy saving features (ESF) can be used in low utilization periods**
- **Net ESF effect also helps mechanical load reduction**

Data Elements Needed to Assess Differences and Build a Rating

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Summary proposed data elements – (Santa Fe)

Operational Elements

- Energy Data = Total Energy (Load)
- Total IT Load
- Tier Level (Reliability)
- Climate Zone
- Type of Center
- Age of Facility
- Square Footage / Stand Alone Center vs. Within Larger Building
- % of Infrastructure Capacity
- % of IT Utilization (Average)

Data Elements Needed to Assess Differences and Build a Rating

- **Summary proposed data elements – (Santa Fe)**

  <u>Quality/Best Practices Elements (Optional*)</u>

  - **Mechanical Systems**
  - **Air Management techniques**
  - **Operating Set Points/Dynamic Temperature Reset**
  - **% of Virtualization**
  - **Growth (how to account for historical changes?)**
  - **LBNL Metrics**
    - **HVAC**
    - **Lighting**
    - **ANCIS: Rack Cooling Index**
    - **ANCIS: Return Temperature Index**

*** Optional should not change index – but might improve the individual index and provide desirable direction in the industry**

Data Elements Needed to Assess Differences and Build a Rating

Element

Mechanical Systems

Definition:

Will the type of mechanical cooling system be an influence on the rating index per type of system – or as a total cost of "mechanical cooling"

Issues / Types:

- **Direct expansion**

  Refrigerant based 1.6 KW/Ton

- **Condenser system**
- **Chilled water**

  Can be designed to 0.4KW/Ton

- **Types of Heat Rejection**
- **Water Cooled IT Equipment**

Data Elements Needed to Assess Differences and Build a Rating

Element

Air Management Techniques

Definition:

The separation of cooled and heated air to eliminate blending (that erodes efficient generation and heat transfer processes)

Issues:

- **Use of blanking plates in racks**
- **Hot aisle / cold aisle equipment layout**
- **CFD modeling**
- **High-delta "T" cooling**
- **Air separation chambers**
- **Air cooled / water cooled racks**
- **Static pressure control**
- **Static pressure boundaries**
- **Dynamically managed air-flow**

Data Elements Needed to Assess Differences and Build a Rating

Element

Operating Set Points (and dynamic Adjustment)

Definition:

With dynamic energy saving features, cooling set-points can be re-set to make DC operation more efficient.

New humidity standards will save energy.

Issues:

- **Raising data center temperatures will reduce data center cost for cooling**
- **ESF will allow dynamic adjustment**
- **Newer equipment with higher inlet temperatures (vendors?)**
- **ASHRAE standards for relaxed humidity standards will reduce need for de-humidification and /or humidity production**

Data Elements Needed to Assess Differences and Build a Rating

Element

% of Virtualization of IT Processing

Definition:

Consolidation, virtualization and technology transformation will save energy outside ESF operation techniques

Issues:

- **Replacing many underutilized servers with partitioned virtual servers increases "IT useful work"**
- **Transition to alternate storage or technology can have an energy reducing effect**
- **The business process replication on the "new" platform must continue reliably**
- **"Predicted" results are usually over-stated**

Data Elements Needed to Assess Differences and Build a Rating

Element

Growth

(how to account for historical changes?)

Definition:

Added growth (or change) of IT load should not significantly influence index

Issues:

- **Will merger activity have an effect on the Data Center index?**
- **Will a change in mainframe to blade IT equipment have an effect on the Data Center index?**

Data Elements Needed to Assess Differences and Build a Rating

Element	Measurements
LBNL Metrics **- HVAC**	• **IT total/HVAC total** • **Fan Watts/cfm** • **Pump Watts/gpm** • **Chiller plant (or overall HVAC) kw/ton**

Data Elements Needed to Assess Differences and Build a Rating

Element	Measurement
LBNL Metrics - Lighting	**Watts/square foot**

Data Elements Needed to Assess Differences and Build a Rating

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Element	Measurement
LBNL Metrics **-ANCIS: Rack Cooling Index**	• **Fraction of IT equipment inlet temperature is within the recommended temperature range**

Data Elements Needed to Assess Differences and Build a Rating

Element	Definition
LBNL Metrics -ANCIS: Return Temperature Index	**(RAT – SAT)/IT^T**

Data Elements Needed to Assess Differences and Build a Rating

- **Summary proposed data elements – (Santa Fe)**

  <u>Quality/Best Practices Elements (Optional)</u>
  - **Mechanical Systems**
  - **Air Management techniques**
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  - **% of Virtualization**
  - **Growth (how to account for historical changes?)**
  - **LBNL Metrics**
    - **HVAC**
    - **Lighting**
    - **ANCIS: Rack Cooling Index**
    - **ANCIS: Return Temperature Index**

Data Elements Needed to Assess Differences and Build a Rating

- **Identify missing elements**
  - **How can additional data be gathered to develop performance metrics?**
    - **Coordination of Benchmark Development Team?**
    - **Vendor compliance to a "standard"**
    - **Industry wide measurement tools**
  - **Development of an EPA benchmark for Data Center efficiency rating**

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Next Steps & Proposed Timeline

- Rating development mtgs – Winter
- Data collection – Spring
- Data review & analysis – Summer
- Share individual rating results – Fall
- Industry rating results mtg – Fall
- Target launch of rating – EOY 2008

ENERGY STAR®
Data Center Infrastructure Rating Development Meeting

energy

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- **Welcome, Introductions, and Meeting Goals –** Michael Zatz, EPA
- **EPA ENERGY STAR Data Center Rating Development Background and Progress –** Alexandra Sullivan, EPA
- **Review of Proposed Data Collection Elements and Template** – Alexandra Sullivan, EPA and William Angle, CSTechnology
- **Proposed Timeline for Data Collection and Rating Development** – Brian Carroll, ICF International
- **Support Needed from Industry** – Michael Zatz, EPA

Background

- Commercial building owners wanted to benchmark data center space in their buildings
- EPA responded: Establish a rating for both stand alone data centers and those located in larger commercial buildings
  - Use existing ENERGY STAR methods and tools
  - Develop a simple, understandable metric
  - Reach agreement with industry on inputs
  - Collect and analyze data
  - Release Data Center rating

Data Center Project Developments

- **October 2007** – Met with industry and collected initial comments
- **December 2007** – Met with industry to collect comments on data inputs
- **January 2008** – Reviewed proposed data collection template with DOE/LBNL
- **February 2008** – Reviewed proposed data collection template with Green Grid, Uptime Institute, AFCOM

ENERGY STAR Rating for Data Center Infrastructure

- **Unit of Analysis:** IT Energy/Total Energy
- **What:** measure of infrastructure efficiency
  - Captures impact of cooling and support systems
  - Does not capture IT efficiency
- **Why:** Best available whole building measure
  - Important to start tracking, measuring, improving
  - Industry still developing ways to understand and measure IT output and efficiency
- **How:** Express ratio (IT/Total) as an ENERGY STAR 1-to-100 rating
  - Percentile of performance
  - Ratio value adjusted for: climate, tier level, other key factors

ENERGY STAR Rating for Data Center Infrastructure

LEARN MORE AT energystar.gov

- ENERGY STAR ratings are based on representative data sample
- Collect data on key characteristics
  - ***Need*** characteristics that define ***what*** the data center does (i.e. redundancy level, climate zone)
  - ***Do not need*** characteristics that define ***how/why*** the data center operates a certain way (i.e. hot aisle/cold aisle configuration or presence of an economizer)
- Analyze Data
  - Characterize the distribution of performance among data centers
  - Normalize for key operating characteristics

Key Questions

- Do you have 12 months of historical utility energy data available?
- Do you have UPS or PDU meters capable of measuring kWh?
- Do you have 12 months of historical kWh energy data for “Total IT Plug Energy” element (taken from UPS and PDU meters)?
- Are there any elements that seem to be missing?
- Are the data elements clear and can you collect them?
- Are the "type" categories (Item 16) complete and exclusive?

Note: live template here

Industry Template Comments

- Industry feedback form will be set to you following today's meeting
- Feedback form due by **Friday, February 22**
- Questions and comments: bcarroll@icfi.com

Next Steps

- **March 6** – Data Collection Kick-Off Meeting
- **March 14** – Deadline to Notify EPA of Your Participation
- Data Submission Deadline
- EPA Data Review and Analysis
- Share Individual Rating Results
- Hold Rating Results Meeting
- Target Launch of Rating in Portfolio Manager

ENERGY STAR®
Data Center Infrastructure Rating Data Collection Kickoff Meeting

March 20, 2008
Web Conference

Web Conference Tips

Discussion

Please identify yourself before speaking.

Background Noise

Please mute your phone until you are ready to speak.

Hold & Music

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Technical Assistance

Call 1.866.229.3239 if you need technical help during the session.

Presentation slides will be sent to all participants following the web conference.

Today's Agenda

- Background: EPA Rating for Data Center Infrastructure
- Final Data Collection Form
- Process and Timeline
- Questions

Background: EPA Rating for Data Center Infrastructure

- Commercial building owners wanted to benchmark data center space in their buildings
  - Existing ENERGY STAR Partners
  - Data center owners and operators
- EPA responded: Set a goal to establish a rating for both stand alone data centers and those located in larger commercial buildings
  - Use existing ENERGY STAR methods and tools
  - Develop a simple, understandable metric
  - Consult with industry and end users on inputs
  - Collect and analyze data
  - Release Data Center rating

Background: EPA Rating for Data Center Infrastructure

- **Unit of Analysis:** IT Energy/Total Energy
- **What:** measure of infrastructure efficiency
  - Captures impact of cooling and support systems
  - Does not capture IT efficiency
- **Why:** Best available whole building measure at this time
  - Important to start tracking, measuring, improving
  - Industry still developing ways to understand and measure IT output and efficiency
- **How:** Express ratio (IT Energy/Total Energy) as an ENERGY STAR 1-to-100 rating
  - Percentile of performance
  - Ratio value will be adjusted for operating constraints outside of the owner/operators control (e.g. climate or tier level)
  - Factors for adjustment to be determined based on data collection and analysis

Background: EPA Rating for Data Center Infrastructure

- ENERGY STAR ratings are based on representative data sample
- Collect data on key characteristics
  - ***Need*** characteristics that define ***what*** the data center does (i.e. redundancy level, climate zone)
  - ***Do not need*** characteristics that define ***how/why*** the data center operates a certain way (i.e. hot aisle/cold aisle configuration or presence of an economizer)
- Analyze Data
  - Characterize the distribution of performance among data centers
  - Normalize for key operating characteristics

Background: EPA Rating for Data Center Infrastructure

- **October 2007** – Met with industry and collected initial comments
- **December 2007** – Met with industry to receive feedback on proposed data inputs
- **January 2008** – Reviewed proposed data collection template with DOE/LBNL
- **February 2008** – Reviewed proposed data collection template with Green Grid, Uptime Institute, AFCOM
- **February 2008** – Met with industry to review updated template and solicit additional feedback
- **March 2008** – Finalized Template

Your Feedback – Thank you!

LEARN MORE AT energystar.gov

- Preference for collecting more operational data and management practices
  - → ***Added an Optional Elements Tab***
- Concern about clarity of the definition for each data element
  - → ***Enhanced the definitions***
  - → ***Added an expanded FAQ sheet***
  - → ***Developed a process to respond to questions during the data collection phase***
  - → ***Will hold live web Q&A sessions during the first few months***
- Lack of historical data
  - → ***Determined to start the data collection now & proceed to June 1, 2009***
- Enthusiasm for participation
  - → ***Thank you – let's begin!***

Note: live template here

Process and Timeline

1. **Receive collection forms from EPA** – March 24, 2008
2. **Commit to participate in project** – ASAP, no later than June 1, 2008
3. **Begin collecting data** – ASAP, no later than June 1, 2008
4. **Submit initial data** – After your first month
5. **Submit interim data** – Quarterly
6. **Participate in update web conferences** – Quarterly
7. **Submit final data** – June 1, 2009

Note: show data collection form here

What should you do now?

- Get started as soon as you receive full instructions via email
- Encourage your data center operators and colleagues/managers/clients to participate in this data collection
- Complete and submit the Expression of Interest Form
- Ensure that the metering of the data center is set up properly
- Start filling out the data collection template to identify any questions you may have

Questions?

During data collection, submit all questions to:

ENERGYSTARDatacenters@icfi.com

ENERGY STAR®
Data Center Infrastructure Rating Development
Question and Answer Session

Web Conference
May 6, 2008

Web Conference Tips

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Technical Assistance

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Presentation Slides

Presentation slides will be sent to all participants following the web conference.

Today's Agenda

- **Welcome, Meeting Goals, and EPA ENERGY STAR Data Center Rating Development Background** – Alexandra Sullivan, EPA
- **Update on Progress of Data Collection** – Alexandra Sullivan, EPA
- **Question and Answer Session** – Alexandra Sullivan, EPA, and William Angle, CSTechnology
- **Closing Remarks** – Mike Zatz, EPA

ENERGY STAR
Data Center Rating Goals

- Build on existing ENERGY STAR platform with methodology similar to existing ratings (1-100 scale)
- Usable for both stand-alone data centers and data centers housed within office or other buildings
- Assess performance at building level to explain how a building performs, not why it performs a certain way
- Provide users with additional resources to help determine next steps after receiving an energy performance rating
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher

ENERGY STAR
Data Center Rating Goals

- Ideal high level metric: kBtu / useful work
- Challenge: how to measure “useful work”?
- Next Steps
  - Agree on “useful work” – challenge industry to reach consensus
  - Implement working metrics for end users while industry discusses definition of “useful work.”

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What is the ENERGY STAR Rating for Data Center Infrastructure?

- **Unit of Analysis:** IT Energy/Total Energy
- **What:** Measure of infrastructure efficiency
  - Captures impact of cooling and support systems
  - Does not capture IT efficiency
- **Why:** Best available whole building measure *at this time*
  - Ideal metric would be measure of energy use/useful work
  - Industry still discussing how to define useful work
  - The critical first step is to start tracking and measuring energy consumption
    - You cannot manage what you do not measure

What is the ENERGY STAR Rating for Data Center Infrastructure?

- **How:** Express ratio (IT Energy/Total Energy) as an ENERGY STAR 1-to-100 rating
  - Each point on rating scale equals 1 percentile of performance
  - Adjust for operating constraints outside of the operators' control (e.g. climate or tier level)
  - Factors for adjustment to be determined based on results of data collection and analysis

Data Needed to Build Rating

- Required data
  - Climate zone (zip code)
  - Type of data center (function)
  - Reliability (Tier Level)
  - Total IT plug energy (12 months of data)
  - Total facility energy usage (12 months of data for all fuels)
- Data needed from a wide variety of facilities (large/small, stand-alone/within larger bldg, etc.)
- EPA estimates that we need good data from a diverse sample of data centers in order to develop the rating

Rating Development Process Overview

- ✓ Consult with industry stakeholders to develop consensus on the use of an IT Energy/Total Energy ratio
- ✓ Develop data collection template, instructions, and support materials
- Gather data on actual energy use from at least 100 existing data centers - IN PROCESS
- Analyze data to develop rating models
- Launch ENERGY STAR Data Center Infrastructure Rating in Portfolio Manager

Data Collection and Rating Development Process

- **June 1, 2008**
  - Participant Expression of Interest forms due
  - Data center operators begin collecting data
- **July 2008:** Participants submit first month of data (as soon as it is collected)
- **Quarterly 2008 – 2009**
  - Interim data submitted
  - EPA holds update web conferences
- **June 1, 2009:** Submit final data
- **January 2010:** EPA launches rating in Portfolio Manager (subject to change)

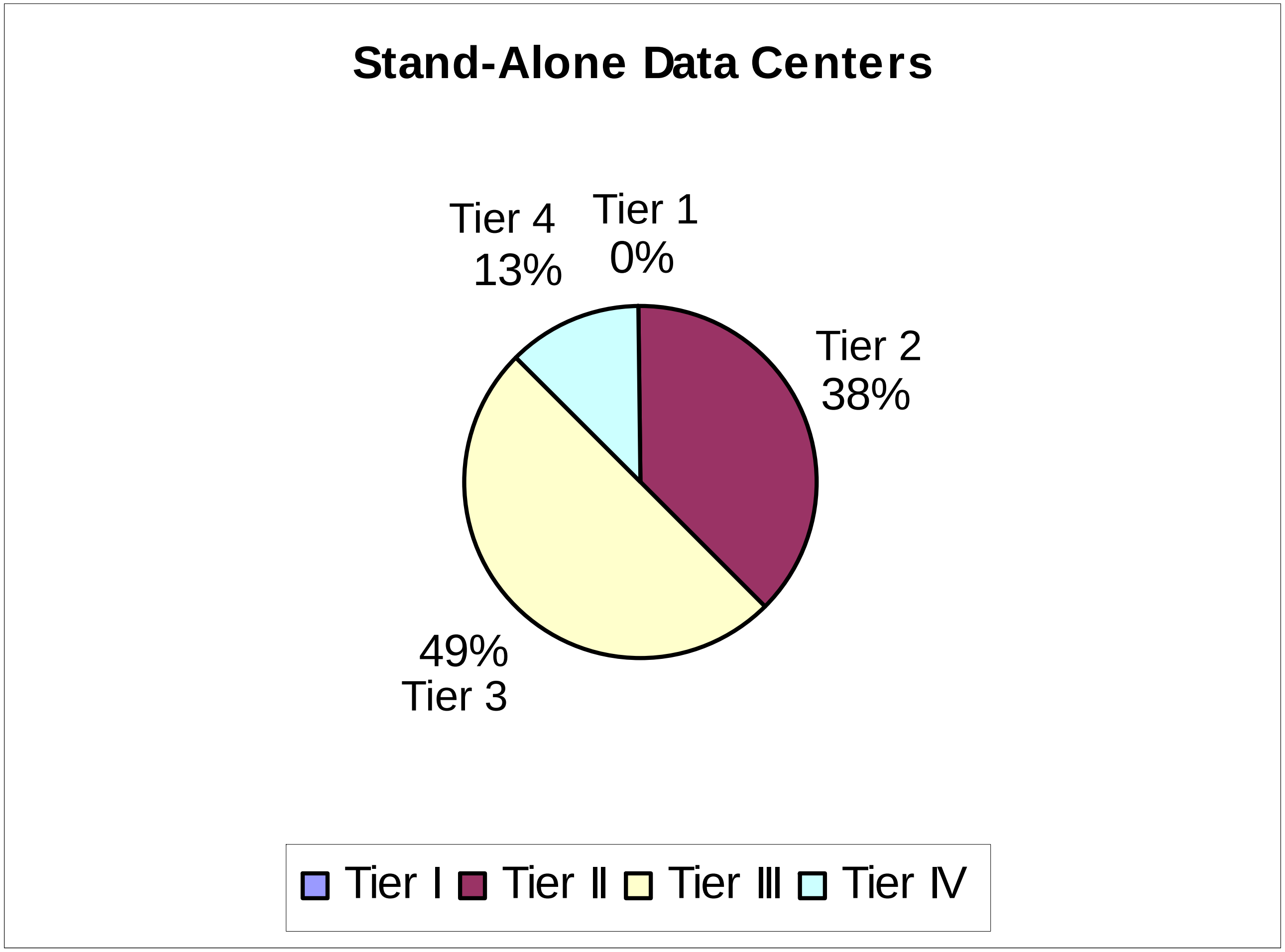
NOTE: If there are an insufficient number of participating data centers by June 2008, the rating may be delayed at least 6 months.

Current Status

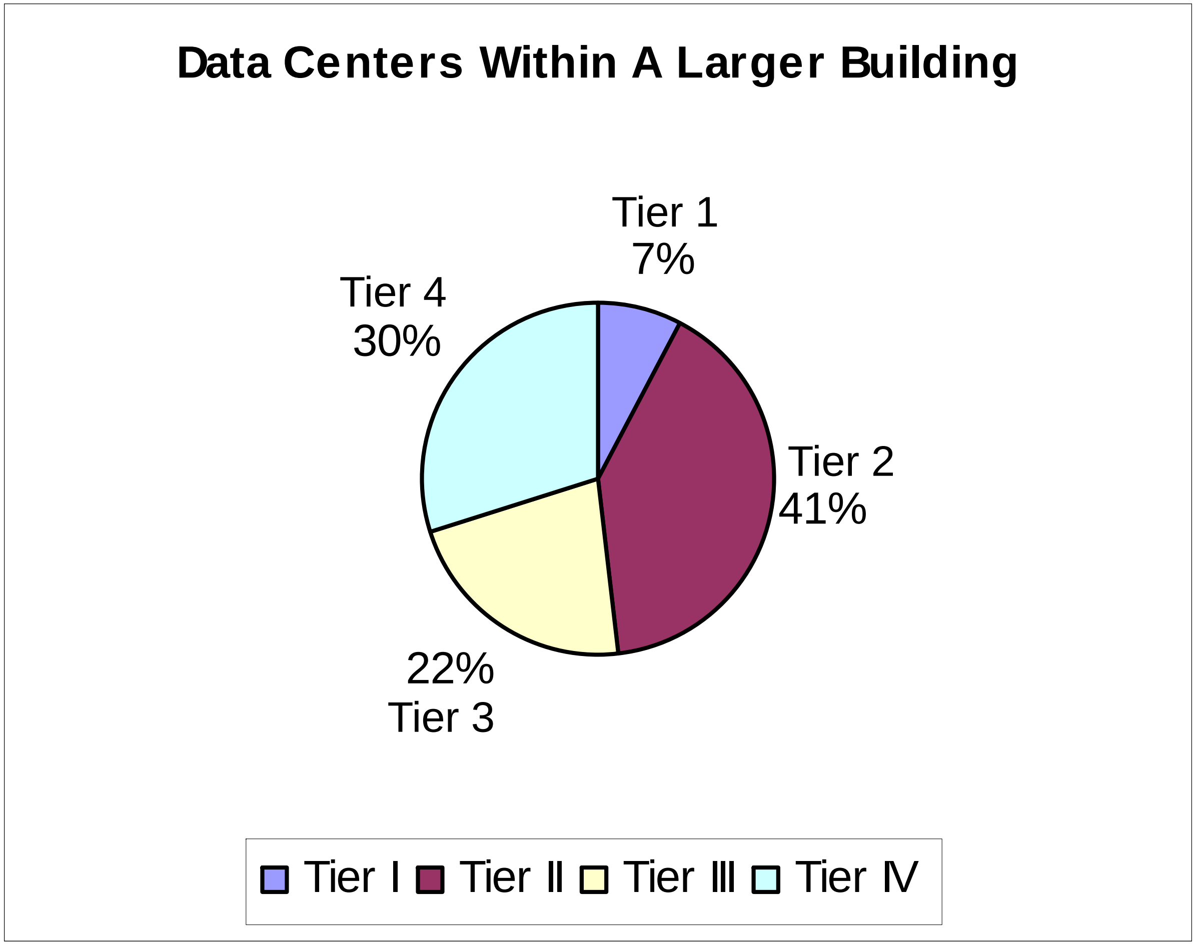
- As of May 5, only 22 companies participating with 43 data centers representing about 3.2 million square feet
- We welcome your participation!

Breakout by Building Type and Tier Level					
	Tier I	Tier II	Tier III	Tier IV	Total
Stand-Alone	0	6	8	2	16
Within a Larger Building	2	11	6	8	27
Total	2	17	14	10	43

Current Status



Current Status



Frequently Asked Questions

- Can international data centers be included in the data collection?
  - Yes. Please give us the data.
  - Cannot guarantee a valid international rating -- we will then evaluate and prioritize locations depending upon the geographical response and climatic data.
- What is the threshold of significance at which the office and other support spaces can be included as part of the data center consumption?*
- How should chilled water be accounted for?
- Does the data collection only include data centers that have chillers?
- How should changes in equipment or equipment power usage be reported?

Frequently Asked Questions

- Can international data centers be included in the data collection?
- What is the threshold of significance at which the office and other connected space can be included as part of the data center consumption?
  - If the total “other spaces” or office space is less than 10% of the load, it can be included with the data center.
  - **Polling Question:** Have you experienced difficulties determining what space should be included in the data center square footage?
- How should chilled water be accounted for?
- Does the data collection only include data centers that have chillers?
- How should changes in equipment or equipment power usage be reported?

Polling Question

Frequently Asked Questions

- Can international data centers be included in the data collection?
- What is the threshold of significance at which the office and other support spaces can be included as part of the data center consumption?
- How should chilled water be accounted for?
  - Use the temperature of the chilled water to provide a thermal unit (such as kBtu or therms)
- Does the data collection only include data centers that have chillers?
- How should changes in equipment or equipment power usage be reported?

Frequently Asked Questions

- Can international data centers be included in the data collection?
- What is the threshold of significance at which the office and other support spaces can be included as part of the data center consumption?*
- How should chilled water be accounted for?
- Does the data collection only include data centers that have chillers?
  - No, a data center with an alternative cooling system (i.e. direct expansion, condenser) can participate. Complete as many cooling-related questions as possible and note the mechanical system type in the Optional Elements form.
- How should changes in equipment or equipment power usage be reported?

Frequently Asked Questions

- Can international data centers be included in the data collection?
- What is the threshold of significance at which the office and other support spaces can be included as part of the data center consumption?*
- How should chilled water be accounted for?
- Does the data collection only include data centers that have chillers?
- How should changes in equipment or equipment power usage be reported?
  - If equipment changes, enter the average value for each quarterly data submission

Additional Questions and Discussion

Get Involved Now!!!

- **Data Center Operators**
  - Complete and submit the Participant Expression of Interest Form ASAP
  - Ensure that data center metering is set up properly
  - Begin completing the data collection template and participate in EPA webinars to learn more
- **Industry Associations**: Encourage your members to participate in this important effort
- **Equipment Suppliers and Consultants**: Encourage your clients to participate in the data collection process

For More Information

Please send questions to:

ENERGYSTARdatacenters@icfi.com

Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters

ENERGY STAR Data Center Infrastructure Rating Development

Data Collection Instructions

Getting Started

Step 1: Complete and return the *Participant Expression of Interest Form*. Email the form to ENERGYSTARdatacenters@icfi.com as soon as possible, and no later than **June 1, 2008**.

Step 2: If the data center is housed in a larger building that does not directly support the function of the data center (such as an office building), ensure that the data center is submetered to isolate data center operations and account for all energy in the data center only.

Step 3: Ensure that equipment is metered properly to allow you to collect the data needed on "Tab 3 – IT Measurement" of the *ENERGY STAR Data Center Data Collection Form* Excel file.

Data Collection Phase

Participants must collect 12 consecutive months of IT and building (whole building if stand-alone or data center portion only if within a larger building) energy use data, and submit this data no later than **June 1, 2009**.

Step 1: Initiate the collection of IT and building energy use data no later than **June 1, 2008**. Be sure to carefully follow all instructions included in the *Data Collection Form* Excel file.

Step 2: Once you have collected 1 complete month of IT and building energy use data, return the *Data Collection Form* Excel file with all tabs completed as thoroughly as possible to ENERGYSTARdatacenters@icfi.com. This will allow for an early review to ensure that you are collecting data as required. Continue recording energy data during and after this submission.

Step 3: Attend the ENERGY STAR data collection Q&A web conference in May 2008. Participants that have begun to collect data will be able to ask questions about the process.

Step 4: Submit your *Data Collection Form* Excel file, completed as thoroughly as possible, to EPA's contractor (ICF International) on a quarterly basis. E-mail the file to ENERGYSTARdatacenters@icfi.com no later than the following dates:

- September 1, 2008
- December 1, 2008
- March 1, 2009

Step 5: Attend ENERGY STAR quarterly web conferences to review progress in the data collection effort and to learn of preliminary findings. These web conferences will be held in October 2008, January 2009, and April 2009.

Send all questions to: ENERGYSTARdatacenters@icfi.com

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Participant Expression of Interest

ENERGY STAR Data Center Infrastructure Rating -- Data Collection

Deadline to Submit Expression of Interest and Initiate Data Collection is June 1, 2008

In an effort to improve energy efficiency in the data center industry, the U.S. Environmental Protection Agency (EPA) is developing an ENERGY STAR Data Center Infrastructure Rating. This rating will help data center operators assess the energy performance of their building's infrastructure and identify buildings with the greatest opportunity for improvement. To develop the ENERGY STAR rating, EPA must collect 12 consecutive months of data on the actual energy use of a wide variety of existing data centers.

This form should be submitted by organizations to express their intent to monitor the energy use of their data centers over the coming 12 months, and to supply this data to EPA's contractor (ICF International) for the purpose of developing the ENERGY STAR Data Center Infrastructure Rating. Data provided will be held only by ICF, and will not be shared with any parties other than EPA. Data shared with EPA will be masked so that the identity of individual data centers cannot be ascertained.

Date: ____________________

Organization Information

Organization Name:			
Primary Business Activity:			
Primary Contact:		Mailing Address	
Title:		Street:	
Email:		City:	
Phone Number:		State:	
Fax Number:		Zip Code:	

Data Center Facilities Information

Please provide the following information for all data centers for which data will be collected.

Data Center Name	City	State	Zip Code	Stand-Alone or within Larger Building	Gross Square Footage	Tier Level as per Uptime Institute (I – IV)

Please return the completed form to: ENERGYSTARdatacenters@icfi.com

For more information, please e-mail or visit: www.energystar.gov/datacenters

ENERGY STAR® Data Center Infrastructure Rating Development Preliminary Results

Web Conference
November 20, 2008

Web Conference Tips

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Technical Assistance

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Presentation Slides

Presentation slides will be sent to all participants following the web conference.

Today's Agenda

- Welcome – Mike Zatz, EPA
- Update on the Status of the Data Collection – Kristen Demeter, ICF
- Clarification of Data Elements – Kristen Demeter, ICF
- Summary of Initial Analysis and Observations – Alexandra Sullivan, EPA
- Participant Q&A and Closing Remarks – Mike Zatz, EPA

Data Center Infrastructure Rating Development Goals

- Build on existing ENERGY STAR platform with methodology similar to existing ratings (1-100 scale)
- Usable for both stand-alone data centers and data centers within office or other buildings
- Assess performance at building level -- how a building performs not why
- Provide users with additional resources to help determine next steps after receiving an energy performance rating
- Offer ENERGY STAR label to data centers with rating of 75 or higher

ENERGY STAR Rating for Data Center Infrastructure

- **Unit of Analysis:** Total Energy/IT Energy
- **What:** Measure of infrastructure efficiency
  - Captures impact of cooling and support systems
  - Does not capture IT efficiency
- **Why:** Best available whole building measure *at this time*
  - Industry still discussing how to define useful work
  - Critical to start tracking and measuring energy consumption – Cannot manage what you don't measure

ENERGY STAR Rating for Data Center Infrastructure

- **How:** Express ratio (Total Energy/IT Energy) as ENERGY STAR 1-to-100 rating
  - Each point on rating scale = 1 percentile of performance
  - Adjust for operating constraints outside of operator control (e.g. climate or tier level)
  - Factors for adjustment based on results of data collection and analysis

Rating Development Process Overview

- ✓ Consult with industry stakeholders to develop consensus on the use of a Total Energy/IT Energy ratio
- ✓ Develop data collection template, instructions, and support materials
- Gather complete data on actual energy use from at least 125 existing data centers - IN PROCESS
- Analyze data to develop rating models - IN PROCESS
- Launch ENERGY STAR Data Center Infrastructure Rating in Portfolio Manager

Data Collection Participation To Date

- **EPA does not have enough data for rating**
- 242 data centers expressed interest to participate
- Preliminary data
  – Complete data submitted: 90 data centers
  – Some data submitted, but missing a few data elements: 25 data centers
- No data from ~50% of data centers expressing interest
- Need complete data for at least 125 data centers to develop a rating

Status of the Data Collection

What is Needed to Continue the Data Collection?

- Those that submitted data
  - Respond to emails with questions about missing or questionable data
  - Continue recording monthly IT and energy data
  - Make any necessary corrections to data based on today's webinar
- Those that expressed interest but have not submitted data
  - Email ENERGYSTARdatacenters@icfi.com as soon as possible if you can now submit data and rejoin the data collection
- All others
  - Join the data collection if you have data beginning in July 2008
  - Recruit data center operators to join the data collection if they meet the above requirement and other eligibility requirements

Upcoming Schedule

- Assuming additional data centers submit data:
  - Next data submission: January 15, 2009
  - Data collection update webinar: Spring 2009
  - Final data submission: June 15, 2009
  - Data analysis and rating development: Summer 2009
  - Webinar to introduce the rating: Fall 2009
  - Launch the rating in Portfolio Manager: January 2010

Clarification of Data Elements

Tab 1: Building Information

- **Stand-alone data center:** the data center should occupy no less than 40% of building
  - Average % of building space in data collection: 59%
  - “Data center space includes rack equipment, service clearance and circulation, control console area, power distribution, and local air conditioning that is encapsulated by the proper protective walls.”
  - Review data center and building square footage

Tab 2: Data Center Operations

- **Values that change over time:** for all data elements, provide averages over period of data collection
  - Use only one line in data collection form per data center for Tab 2
- **Number of racks**: refer to additional FAQs developed for the number of racks and rack space equivalent
  - Sent to participants with missing data on 8/11/08
  - Posted on ENERGY STAR Web site soon
- **Cooling data elements:** assumes chillers are used to cool data centers
  - If DX unit or alternative cooling system used, indicate on data collection form

Tab 2: Data Center Operations (cont.)

- **Annual chiller runtime (hours):** total number of hours cooling system is operating for 1 year
  - Should not exceed 8,760 hours (24 hrs x 365 days)
  - Count number of hours chillers run, *regardless of number* running (i.e. do not count 8,760 hrs x 2 chillers for a total of 17,520 hrs)
- **Average chiller demand (KW)**
  - **Kilowatt** reading found on meter on chiller or in building automation system

Tab 3: IT Measurement

- Provide all meter readings in KWH
- UPS and PDU meter data should be recorded during same time frame
- IT energy recorded at UPS meter should be higher than PDU meter
- Data where the UPS meter reading = energy consumption **cannot be used** since it creates a PUE of 1!

Tabs 4-6: Energy Data

- Start and end dates should align with IT plug energy
- All purchased energy sources (including chilled water) should be included in Tab 6 (Other Energy Sources)
- For data centers within larger buildings
  - Lighting load must be included in data center's energy data; if not captured by electricity meter, see additional FAQs posted on Web site
  - *Cooling load for data center* must be included in annual electricity consumption, meaning chiller or cooling equipment must be metered

Summary of Initial Analysis and Observations

Overall Response

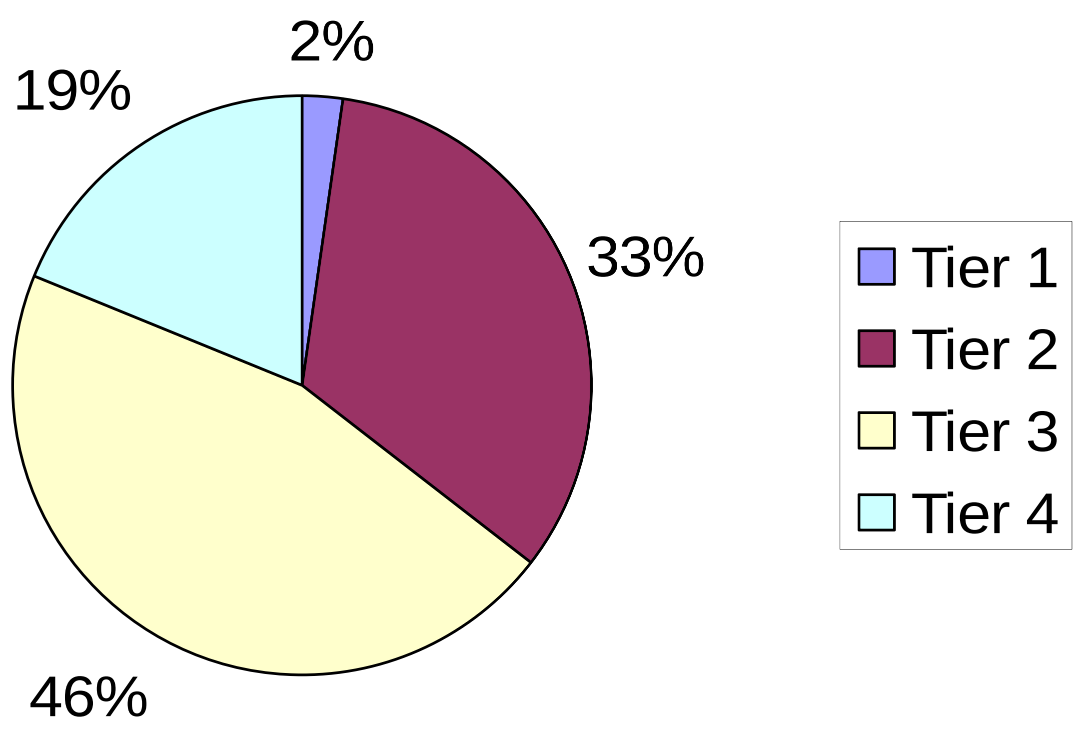
- Expression of interest: 242 data centers
- Preliminary data
  - Some data: 115 data centers
  - Complete data: 90 data centers
- No data from about half
- Need complete data for at least 125 data centers to develop a rating

→ ***EPA does not currently have enough data***

Building Type

- Approximately half of the data centers are free standing
  - 48 stand alone data centers
  - 42 data centers within larger buildings
- Some data centers have already earned recognition
  - 2 ENERGY STAR buildings
  - 1 LEED certified building

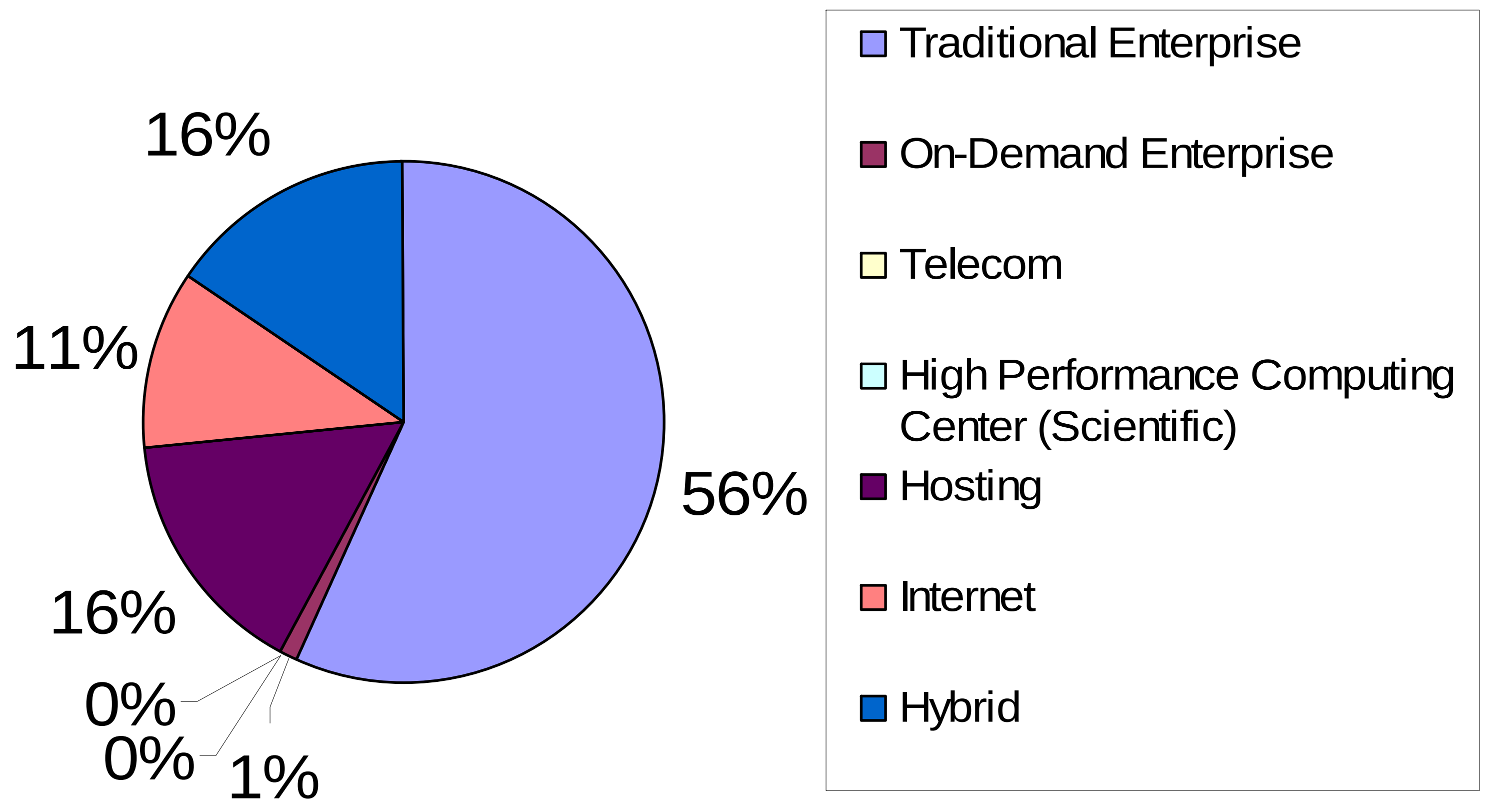
Tier Level



Tier Level

- Nearly half are Tier 3
- Good representation of Tier 2, 3, and 4
- Only two Tier 1 data centers
  - Rating may not be able to apply for Tier 1
- ***Question for you***
  - Are Tier 3 data centers the most common?
  - If not, why do we think they are the largest part of this sample?

Data Center Type



Data Center Type

- Types represented
  - Traditional enterprise data centers (over 50%)
  - Hosting, internet, and hybrid facilities
- Types not well represented
  - No telecom or high-performance computing centers
  - One on-demand enterprise center
- ***Question for you***
  - Are traditional enterprise data centers the most common facilities?
  - If not, why do you think they are so prevalent in this data set?

Data Center Size

	Minimum	Maximum	Average
Data Center (ft^2)	450	300,000	51,293
Building (ft^2)	10,000	2,000,000	258,412
Data Center as percent of total*	19%	100%	59%

for stand alone data centers only

Data Center Size

	Minimum	Maximum	Average
Number of Racks	8	4974	992
Percent Utilization	8%	99%	56%
Year of Construction	1959	2008	1995

Source and Site Energy

- ENERGY STAR rates the whole building and must account for any mix of fuels
- Site Energy
  - Energy consumption expressed on utility bills
  - Includes combination of primary and secondary energy, which are not directly comparable
    - Some heat and electricity comes from fuels burned on-site (e.g. natural gas), while some comes from fuels burned off-site (e.g. district chilled water)

Source and Site Energy

- Source Energy
  - Traces on-site consumption back to energy content of primary fuels
  - Accounts for the losses in conversion from primary to secondary energy (which can occur either on-site or at a utility)
  - Accounts for losses in distribution to buildings

→ EPA recommends the use of source energy and will pursue this in our analysis

Source and Site Energy

- Benefits of source energy
  - Fair comparison of data centers with different fuel mixes
    - Account for primary and secondary energy
  - Consistency with other EPA ratings
  - Ratings that track more closely with energy cost and emissions
  - Complete thermodynamic assessment of building

IT Load

- EPA requested measurements at:
  - UPS output
  - PDU input
- Data centers do not all have both measurements
  - 72 data centers provided UPS readings
  - 37 data centers provided PDU readings
- EPA will perform preliminary work with UPS readings for IT Load
- EPA will compare analyses with UPS and PDU readings
  - May benefit from more data
  - How different are UPS and PDU readings when both are available?

Energy Performance

- Standard performance ratio values:
  - PUE: Total Energy/IT Energy
    - Commonly used and understood
    - Lower numbers are better
    - Most analogous to energy intensity metric for commercial/industrial facilities: energy ***per*** output
    - EPA industrial program uses energy ***per*** output (e.g. to rate an automobile manufacturing plant)
  - DCiE: IT Energy/Total Energy
    - Ranges from 0 to 1
    - Higher numbers are better
- EPA will begin work with PUE

Energy Performance

- Site and Source PUE
  - computed for 66 facilities
  - Some with unexpected values were removed
    - (e.g. PUE = 1)
  - Average Site PUE: 2.3
  - Site and source values the same if all electric
  - Will investigate high and low outliers

	Minimum	Maximum	Mean
Site PUE	1.114	16.33	2.31
Source PUE	1.114	16.33	2.21

Energy Performance

- Hosting facilities appear to have higher PUE
- Not a good sample for On-Demand or Internet

Type	Mean Site PUE	Number
1 – Traditional Enterprise	2.08	41
2 – On-Demand Enterprise	1.60	1
5 – Hosting	3.20	10
6 – Internet	1.53	2
7 – Hybrid	1.96	12
All	2.20	66

Energy Performance

- Higher tier levels appear to have higher PUE values
- No Tier 1 data centers provided UPS data

Tier Level	Mean site PUE	N
2	1.98	16
3	2.41	37
4	2.44	13
Total	2.31	66

Summary

- Not enough complete data to develop rating
- Existing participant data must be complete and accurate
- Minor issues with data elements can easily be corrected to complete data submission
- Those who have not submitted data should submit ASAP
- EPA will use PUE (Total Energy/IT Energy) if rating development continues

Upcoming Schedule

If additional data centers submit data:

- Next data submission: January 15, 2009
- Data collection update webinar: Spring 2009
- Final data submission: June 15, 2009
- Data analysis and rating development: Summer 2009
- Webinar to introduce the rating: Fall 2009
- Launch the rating in Portfolio Manager: January 2010

For More Information

Please send questions to:

ENERGYSTARdatacenters@icfi.com

Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters

ENERGY STAR® Data Center Infrastructure Rating Development Update and Preliminary Results

Web Conference

May 7, 2009

Web Conference Tips

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Presentation Slides

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Agenda

- Welcome
- Rating Development Update
- Preliminary Data Analysis
- Next Steps
  - ***We need your full year of data!***
- Participant Q&A and Closing Remarks

Rating Development Objective

- Build on existing ENERGY STAR methods and platforms
- Apply to stand-alone data centers and data centers housed within office or other buildings
- Assess performance at the building level to explain how a building performs, not why it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)

Rating Development Objective

- Application of EPA Methodology for Data Centers
  - Express ratio (Total Energy/IT Energy) as an ENERGY STAR 1-to-100 rating
  - Each point on rating scale equals 1 percentile of data centers
  - Adjust for operating constraints outside of the owner/operators control (e.g. climate or tier level)
    - Target ratio will depend on specific operational constraints
  - Factors for adjustment to be determined based on results of data collection and analysis

Rating Development Timeline

- October 2007 – March 2008
  - Consultations with industry stakeholders
  - Reached agreement on the use of the ratio: Total Energy/IT Energy
  - Developed requirements for data collection
    - What elements are necessary to collect?
  - Developed data collection template
    - Key elements and definitions
    - User-friendly Excel form

Rating Development Timeline

- March 2008 – Launched data collection
  - Collection period: March 2008 – June 2009
    - Need 1 full year of data per participant
    - Need measured total energy and IT energy
    - Need operational information (e.g. tier level, number of racks, climate zone)
  - Template available at www.energystar.gov/datacenters
  - Expression of interest from 242 data centers

Rating Development Timeline

- August 2008 – Preliminary reporting
  - Data submitted to EPA for review from 90 data centers
    - Only 66 with complete and reasonable data
    - Opportunity to work through measurement and reporting questions
  - Enough data to perform basic analysis
  - Average characteristics
    - 51,000 square foot
    - 56% utilization
    - Mean PUE of 2.2

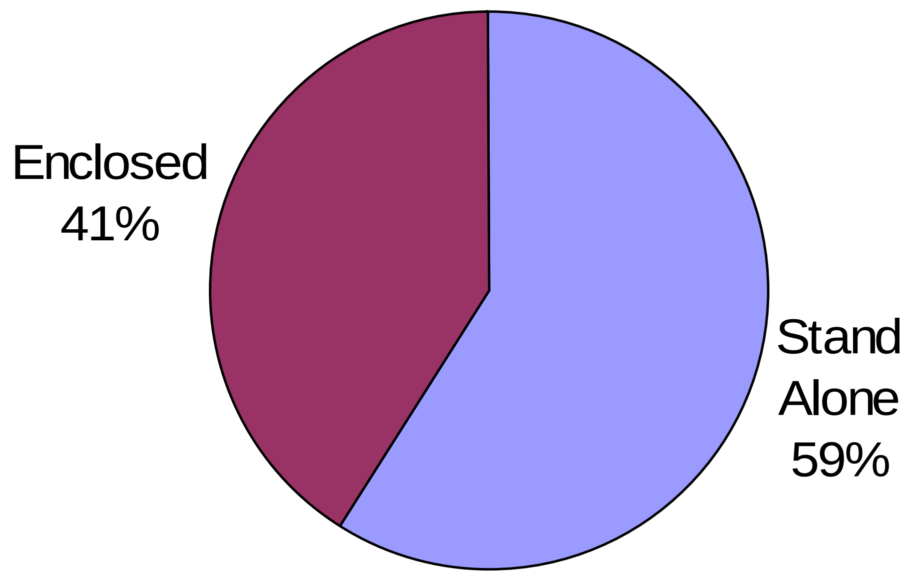
Rating Development Timeline

- November 2008
  - Update to industry
  - Positive results from August collection
  - Concerns about having adequate data
- January 2009
  - Second data reporting deadline
  - Over 100 data centers submitted data
- ***Today***
  - Opportunity to share analysis from January submittal

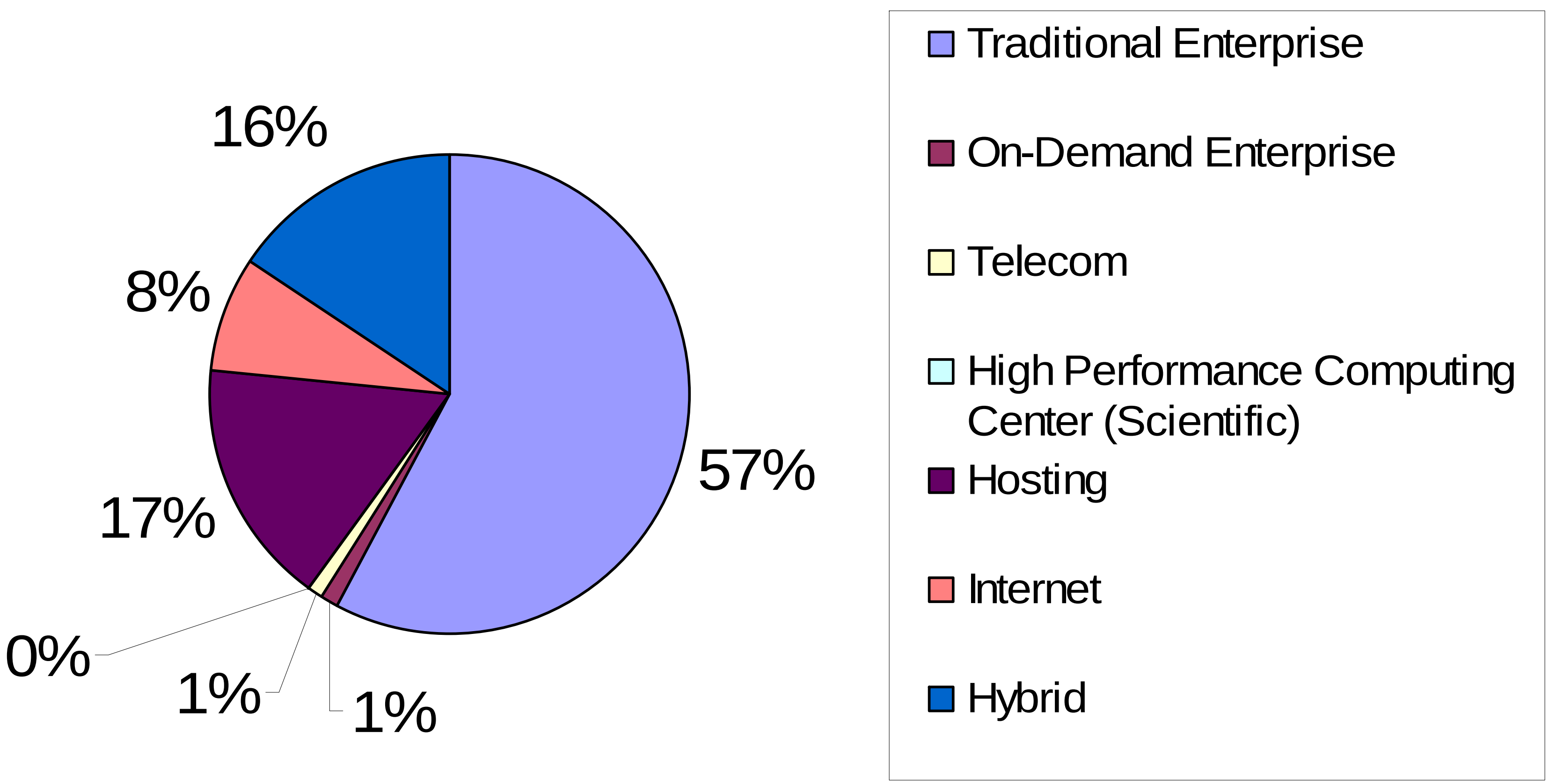
Rating Development Preliminary Analysis

- January Data Submittal
  - 103 Submitted new or updated data
  - 115 Total records
  - 90 Complete records for analysis
    - Must have included UPS
    - Must have reasonable values (e.g. no PUE=1)
- Good number of data points
  - Ideally will get more in final submittal
  - Want to have over 100 complete records
  - Working through data questions with participants

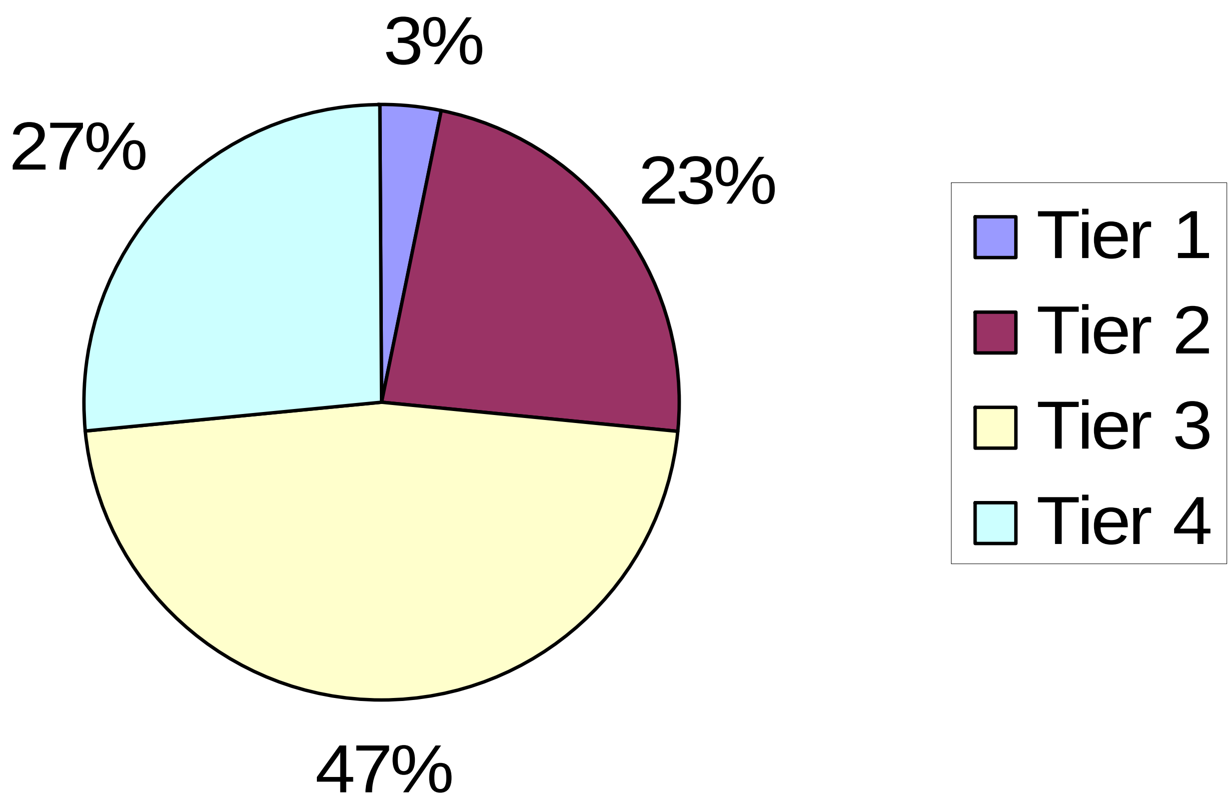
Building Type



Data Center Type



Tier Level



UPS and PDU Readings

- UPS more common than PDU readings
  - 11 data centers with PDU but no UPS reading
- Eliminated records without UPS from this preliminary analysis to provide consistent sample for all metrics and averages
- ***Questions***
  - ***Why don't some facilities have UPS readings?***
  - ***Could these be obtained in the future?***

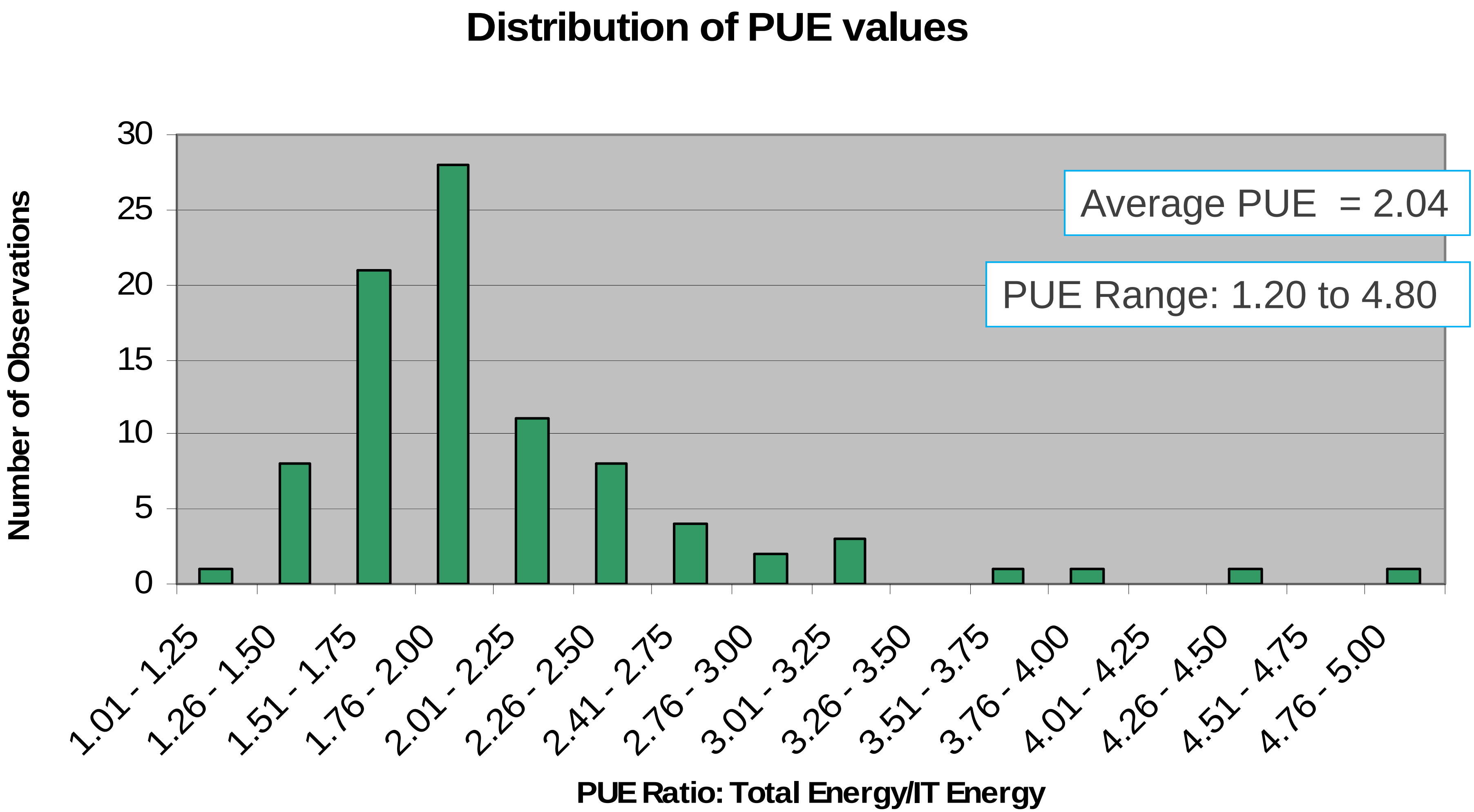
UPS and PDU Readings

- 90 data centers in sample
  - 34 have both PDU and UPS readings
  - 56 have UPS readings only
- UPS to PDU losses
  - Ratio of UPS/PDU
  - Average = 1.14
  - Range = 1.01 to 1.75
- ***Questions:***
  - ***Why are the losses so high between the UPS and PDU readings?***
  - ***On average almost 14%?***

UPS and PDU Readings

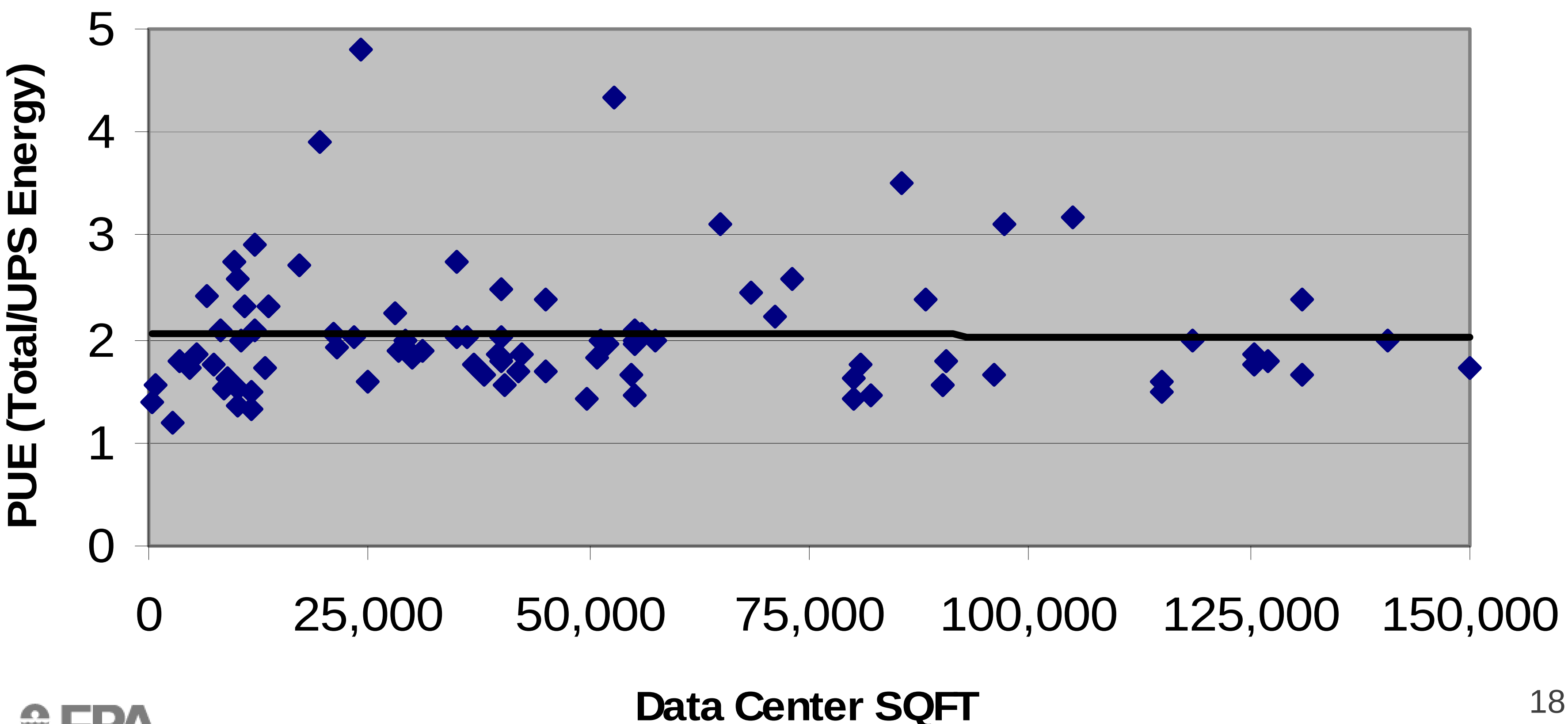
- Going forward
  - EPA rating will likely be based on UPS readings as the proxy measurement for IT energy
- Options for users who do not have UPS readings? ***(under consideration)***
  - Accept PDU reading instead
  - Apply a uniform multiplier to convert PDU to UPS reading
  - Do not accept PDU readings – require UPS to get a rating
- ***Question***
  - ***What do you think?***

PUE Measurements



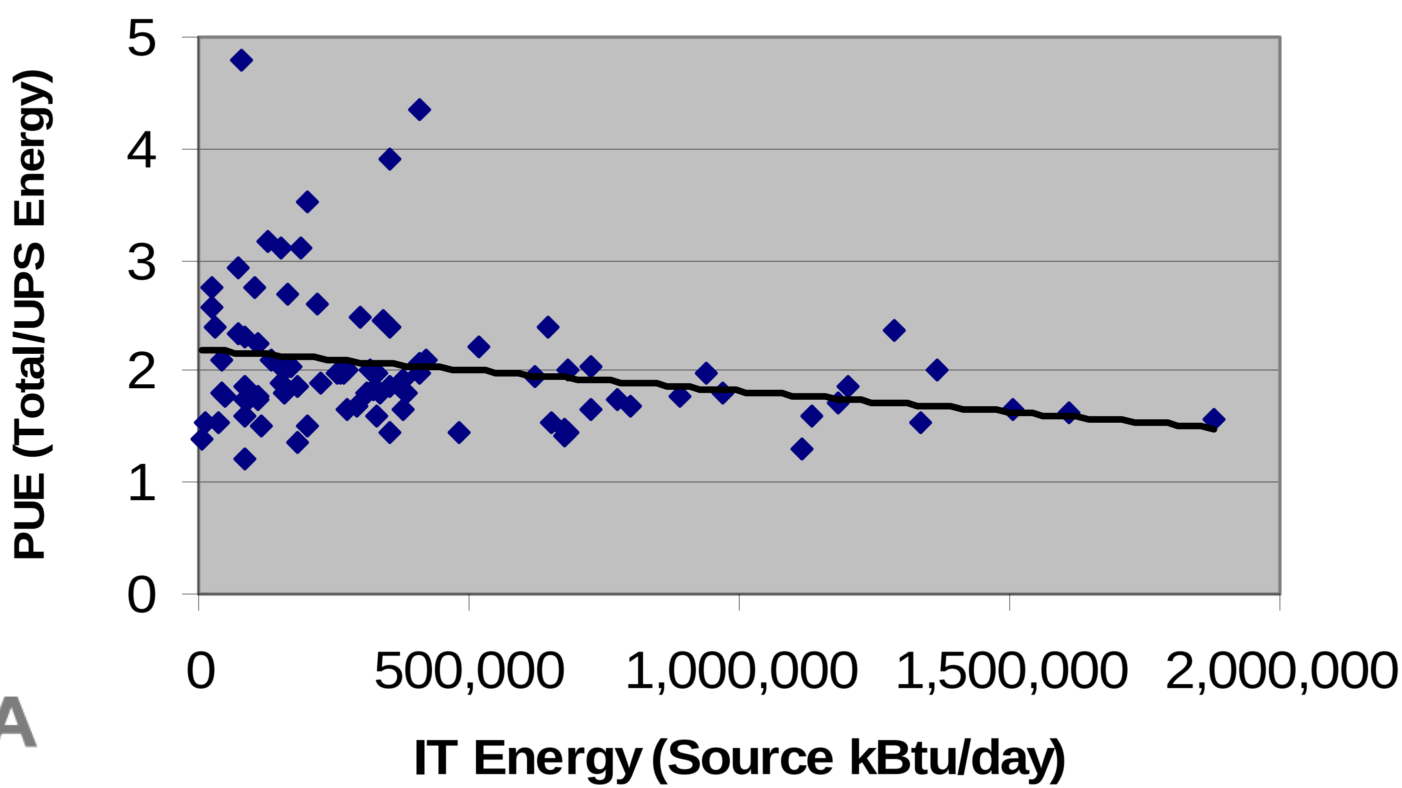
PUE Measurements

- As expected PUE is not related to data center square foot



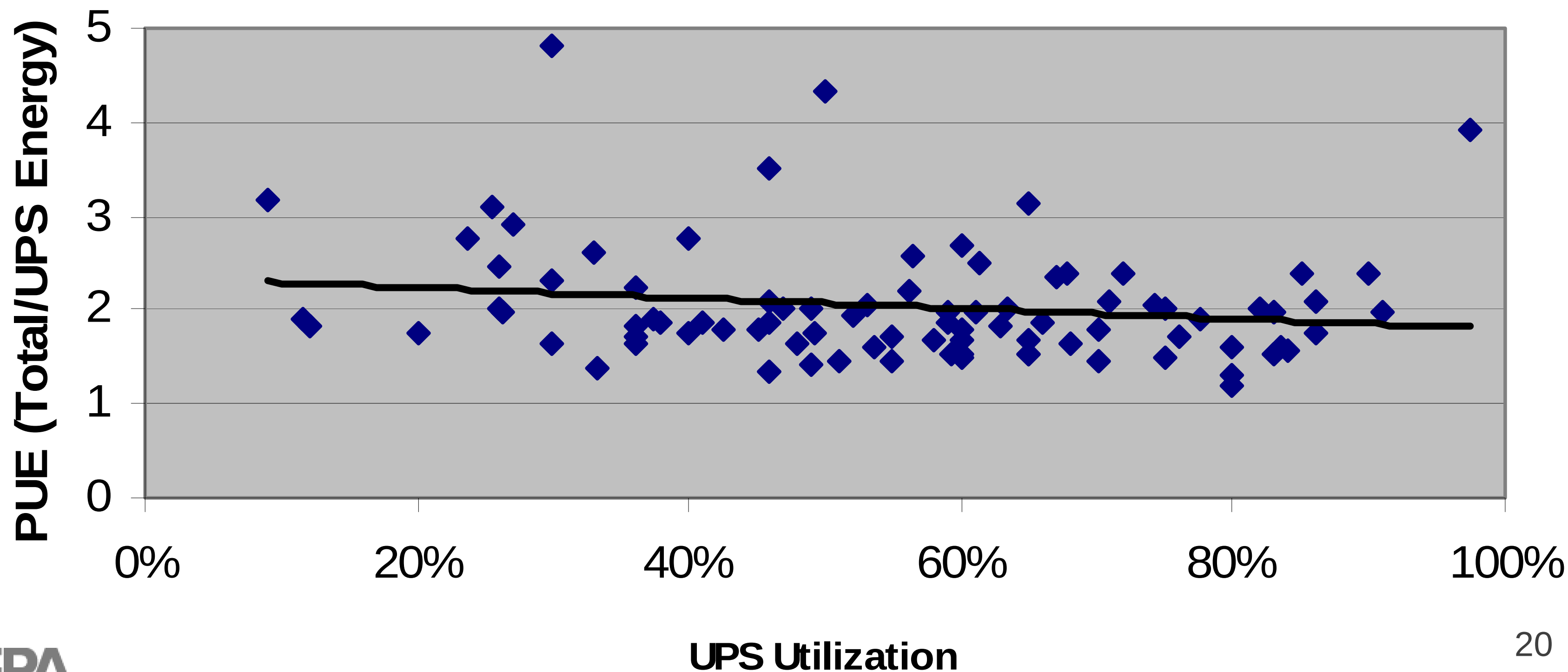
PUE Measurements

- PUE seems to be lower in buildings that have higher total UPS Energy (IT Energy)
  - ***Question: Is this an economy of scale?***



PUE Measurements

- Also a trend for lower PUE at facilities with greater percent UPS utilization
  - ***Question: Does this make sense?***



PUE Measurements and Tier Levels

- Tier 3 and 4 have higher PUE than Tier 1 and 2
  - Tier 3 have higher PUE than Tier 4

Tier level	Count	Percent	Average PUE
Tier 1	3	3%	1.88
Tier 2	21	23%	1.84
Tier 3	42	47%	2.14
Tier 4	24	27%	2.05
All	***90***	***100%***	***2.04***

PUE Measurements and Tier Level

- ***Questions***
  - ***Why do you think Tier 4 centers have lower PUE than Tier 3 centers?***
    - More sophisticated management and technology?
    - Should not be significantly different?
    - Other reasons?

PUE Measurements and Data Center Operation

- Most data centers are traditional enterprise
- The hosting and hybrid facilities (smaller number) have slightly lower PUE values on average
- There are no high performance/scientific centers, and only 1 each of On-Demand Enterprise and Telecom
  - These are not shown

Data Center Operation	Count	Percent	Average PUE
Traditional Enterprise	52	58%	2.08
Hosting	15	17%	1.93
Internet	7	8%	2.09
Hybrid	14	16%	1.98
All Data Centers	***90***	***100%***	***2.04***

PUE Measurements and Data Center Operations

- ***Questions***
  - ***Does the sample seem to over-represent Traditional Enterprise Data Centers?***
  - ***Why might hosting or hybrid facilities have lower PUE values?***
    - This trend is also observed when Tier 3 and Tier 4 are examined individually

Next Step

We need your data!

- Who:
  - ALL OF YOU
  - Even if you have already submitted data – updated data is required (one full year)
- What:
  - Minimum of 11 consecutive calendar months for all meters
  - Responses for all required questions on data collection form
  - Willingness to respond to questions to iron out missing and/or inconsistent figures

Next Steps
We need your data!

- When
  - ***As soon as possible!***
  - No later than June 15, 2009
  - Prefer NOW – as soon as you have one year of data
- How:
  - Submit final data to:
    - ENERGYSTARdatacenters@icfi.com
    - KDemeter@icfi.com

Next Steps

- Now – June 15, 2009
  - Participants submit data
  - ***Please submit as soon as possible***
- Summer 2009
  - Regression analysis of data at EPA
- Fall 2009
  - Meeting to share analytical results and model recommendations
- January 2010
  - Target release for new rating model in Portfolio Manager
  - This depends on your data!

For More Information

Please send questions to:

ENERGYSTARdatacenters@icfi.com

Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters

ENERGY STAR®
Data Center Infrastructure Rating Development Update

Web Conference

September 29, 2009

Web Conference Tips

Background Noise

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Presentation Slides

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Agenda

- Welcome
- EPA Ratings
  - Objective
  - Technical foundation
- Data Collection Summary
- Preliminary Analytical Results
- Next Steps

Rating Development Objective

- Build on existing ENERGY STAR methods and platforms
- Apply to stand-alone data centers and data centers housed within office or other buildings
- Assess performance at the building level to explain how a building performs, not why it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)

Rating Development
Data Center Efficiency Metric

- Define data center efficiency as:

  Energy Usage Effectiveness (EUE) = Total Energy / UPS Energy

- EUE is based on energy, not power
  - Total Energy includes all fuels (electricity, natural gas, diesel, etc.)
- EUE is based on source energy, not site energy
  - Source Energy is the total amount of raw fuel required to operate the building
  - Results in equitable comparisons for buildings with different fuel types utilized

Rating Development
EPA Methodology

- Express data center efficiency as an ENERGY STAR 1-to-100 rating
  - Each point on rating scale equals 1 percentile of data centers
- Adjust for operating constraints outside of the owner/operators control (e.g. Tier level)
  - Target efficiency will depend on operational constraints
- Factors for adjustment to be determined based on results of data collection and analysis

EPA Ratings: Technical foundation

- Develop the regression model
  - Account for building operations (e.g., UPS Energy, Tier)
- Apply a linear regression model

$$EUE = C_o + C_1 * \text{UPS Energy} + C_2 * \text{Tier} + \ldots$$

  - Coefficients represent average responses
  - Coefficients provide adjustments for each operational characteristic
    - ***Does not*** add the kWh of each piece of equipment
    - ***Does*** adjust energy based on correlation between operating characteristic and energy use

Rating Development Timeline

- October 2007 – March 2008
  - Consultations with industry stakeholders
  - Agreed on use of the ratio: Total Energy / IT Energy
  - Developed data collection template
- March 2008 – June 2009
  - Data collection
- August & November 2008, May 2009
  - Updates to industry
- June – November 2009
  - Analysis & Rating Development
- Spring 2010
  - Data center model scheduled for release

Data Collection Summary

- **Thank you for your participation!**
- Reviewed all data to identify records that were complete & correct
  - All required building attributes
  - 11 months of energy data
  - 11 months of IT data
- 121 Data Centers submitted complete data
- Good variability in data
  - Locations in 24 different states
  - Mix of sizes, types, Tier levels

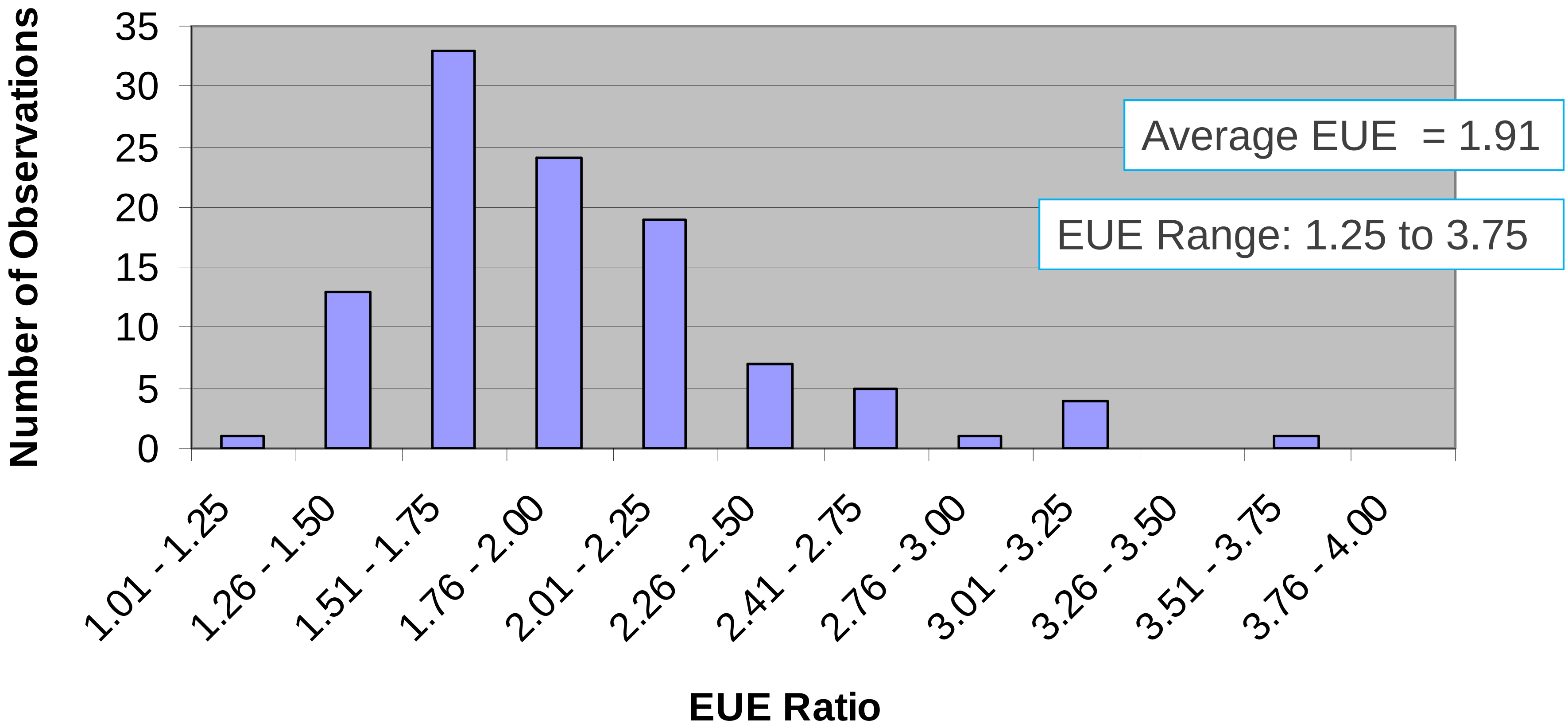
UPS vs. PDU Data

- Data collection requested both UPS and PDU data for IT energy, if available
- UPS more common than PDU
  - 108 Data Centers with data from the UPS meter
  - 42 Data Centers with data from the PDU meter
  - Above totals include 29 that provided both UPS and PDU data
- Not enough PDU data to develop a rating
- Using UPS data provides more data centers with the ability to rate performance
- *EPA rating will likely be based on UPS readings as the proxy measurement for IT energy*

Stand Alone vs. Enclosed

- Mix of Stand Alone and Enclosed data centers
  - 61 of the 108 data centers with UPS data are Stand Alone
  - 47 of the 108 data centers with UPS data are Enclosed
- Tested models with Stand Alone and All Data Centers
  - Energy performance ratings are similar
- Benefits of using Stand Alone Data Centers:
  - Overall significance of models is higher
  - Similar to EPA ratings for other space types
- Benefits of using All Data Centers:
  - Significance of certain operating characteristics is higher
  - Greater number of observations
- *No decision yet on which data to use for a final model*
  - *Model performance statistics will differ, but ratings will be similar*
  - *Rating should still apply to both Stand Alone and Enclosed*

Distribution of EUE Ratios



Data Center Analysis: Model results

- Some surprising results for operating characteristics to be included/excluded, but these are supported by data
- EUE is fairly independent of operating characteristics, as compared with similar models for commercial buildings
- Few operating characteristics expected to be included in a final model
- Relatively low R-squared expected, but still acceptable

Conclusions:

- Variability in energy use is more dependent on energy management practices than operating characteristics
- Despite the low R-squared, regression modeling results in meaningful adjustments for some operating characteristics

Data Center Analysis: Model results

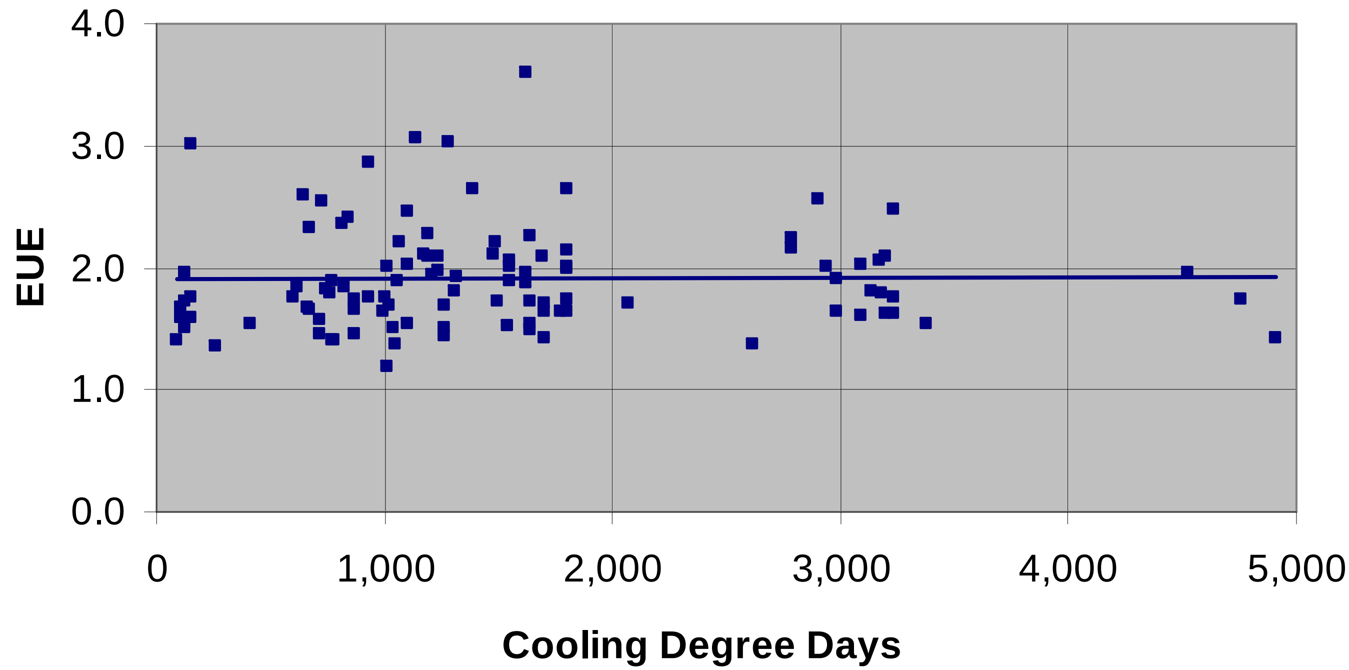
- Variables that ***may be*** included in the model and are still under investigation by EPA (*Statistically significant in some model options with 80% confidence or better)*
  - UPS Energy Intensity (IT energy per square foot)
  - UPS Energy (total IT energy)
  - Square Feet
  - Tier (or some similar measure of redundancy)

- Variables that are ***not*** likely to be included in the new model (*Not statically significant in most model formulations)*
  - Heating Degree Days (HDD)
  - Cooling Degree Days (CDD)
  - Data Center Type (traditional, hosting, internet, etc.)
  - UPS Utilization

Variables ***Not*** Likely to be Included in a Data Center Rating Model

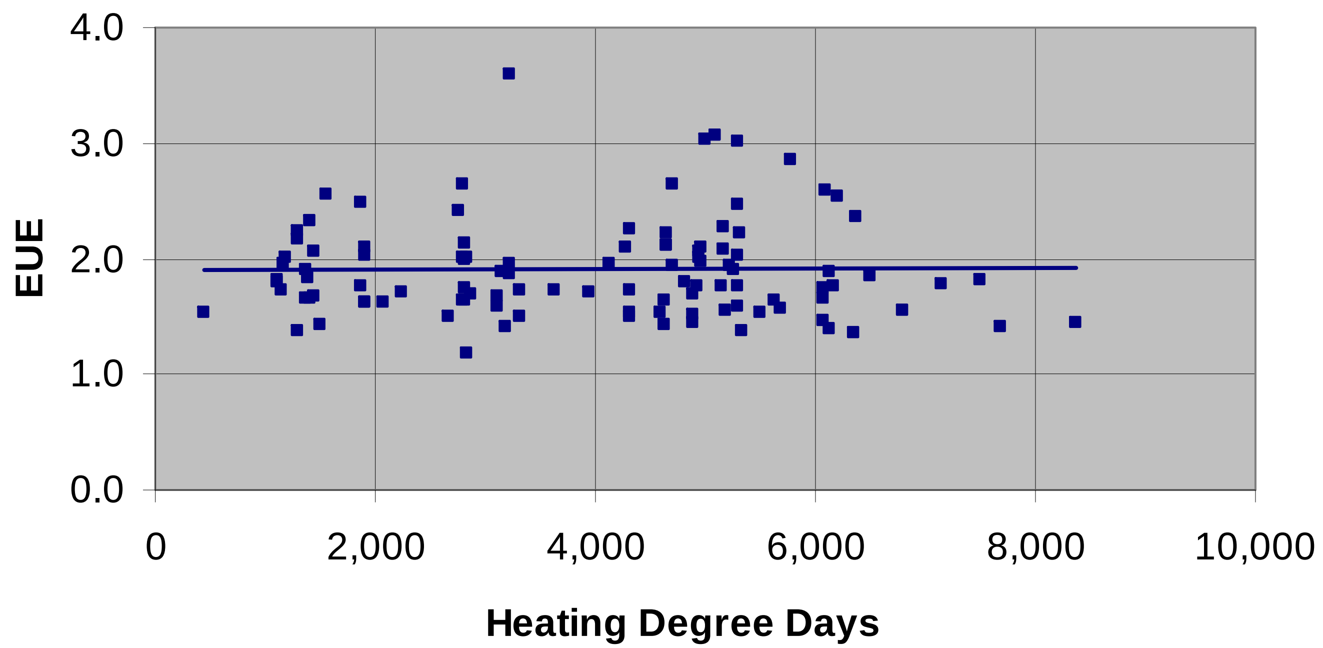
Cooling Degree Days

- No dependence of EUE on Cooling Degree Days
- Unexpected result



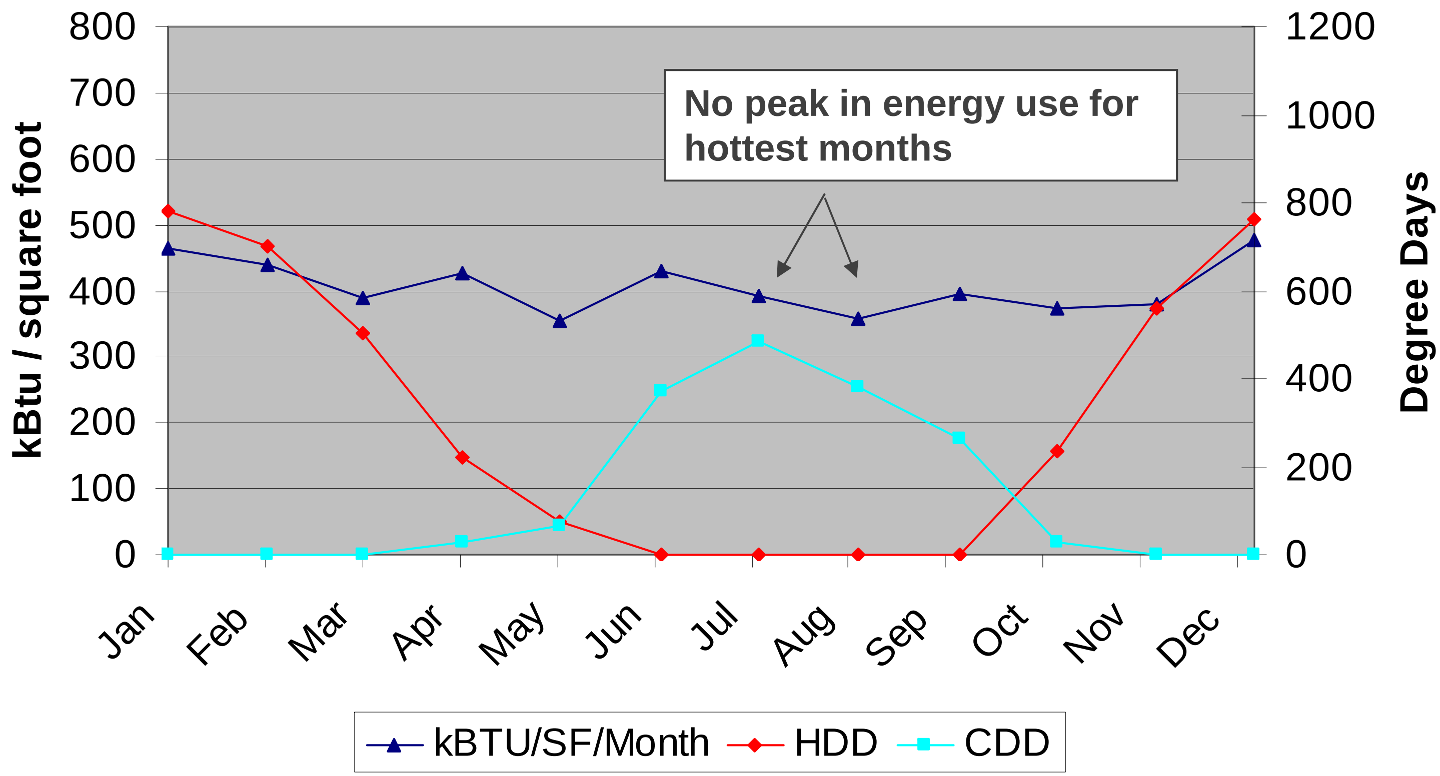
Heading Degree Days

- No dependence of EUE on Heating Degree Days
- Unexpected result



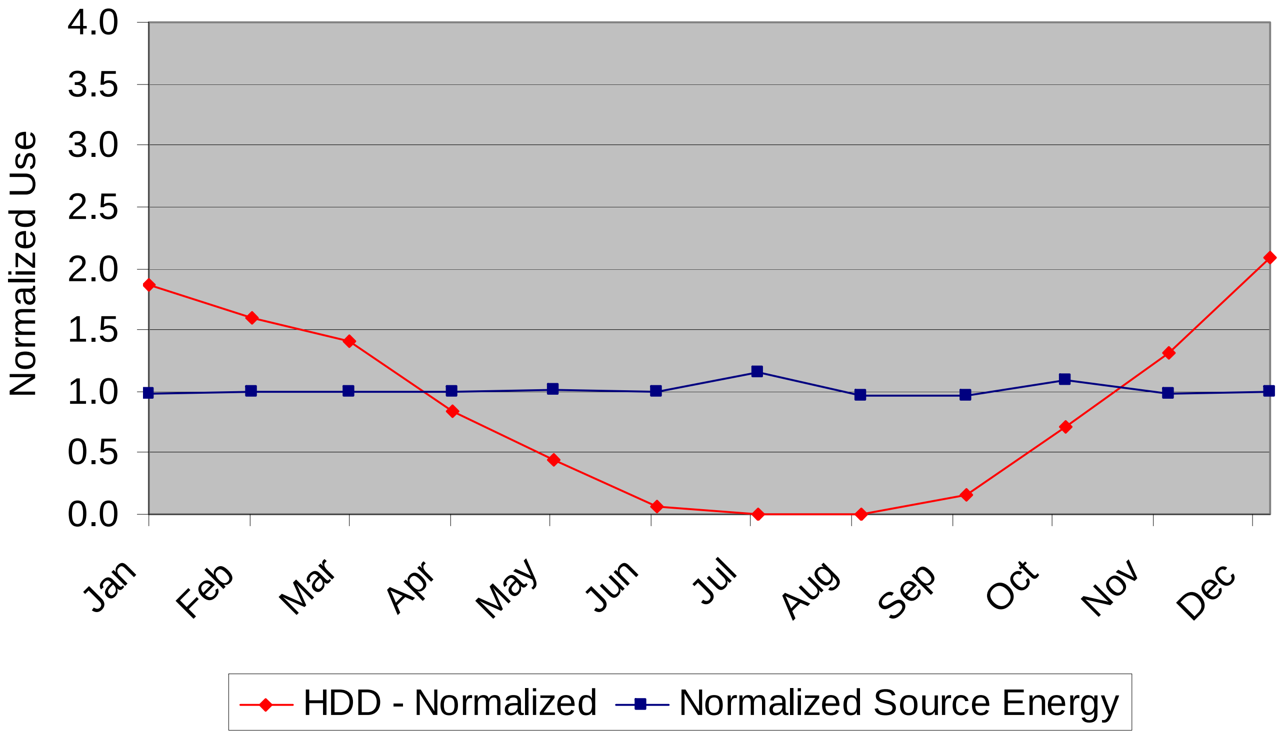
Monthly Energy Consumption Sample Data Center

- Sample Data Center shows little variability in monthly energy consumption
  - *Annual HDD = 4121, annual CDD = 1623*



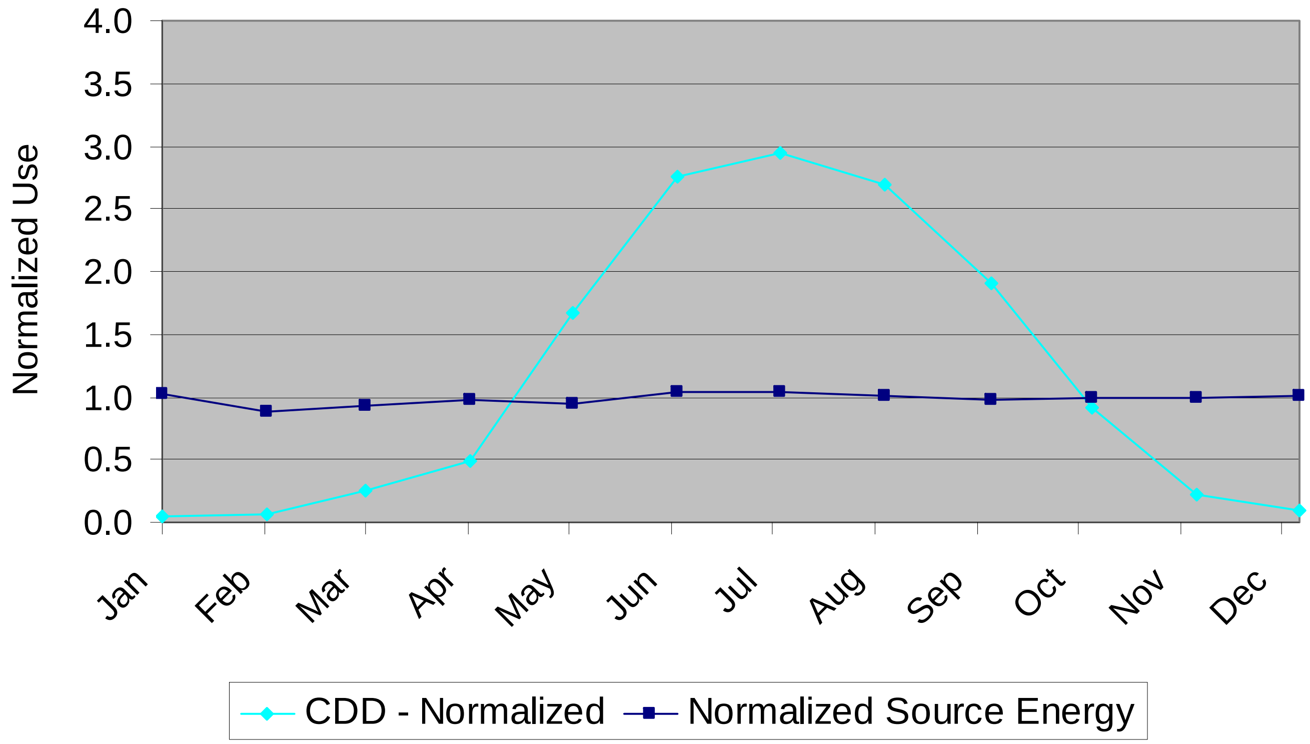
Monthly Energy Consumption
10 Coldest Climates

- Data Centers in 10 coldest climates show no variability in monthly energy consumption
- *10 buildings with annual HDD > 5976*



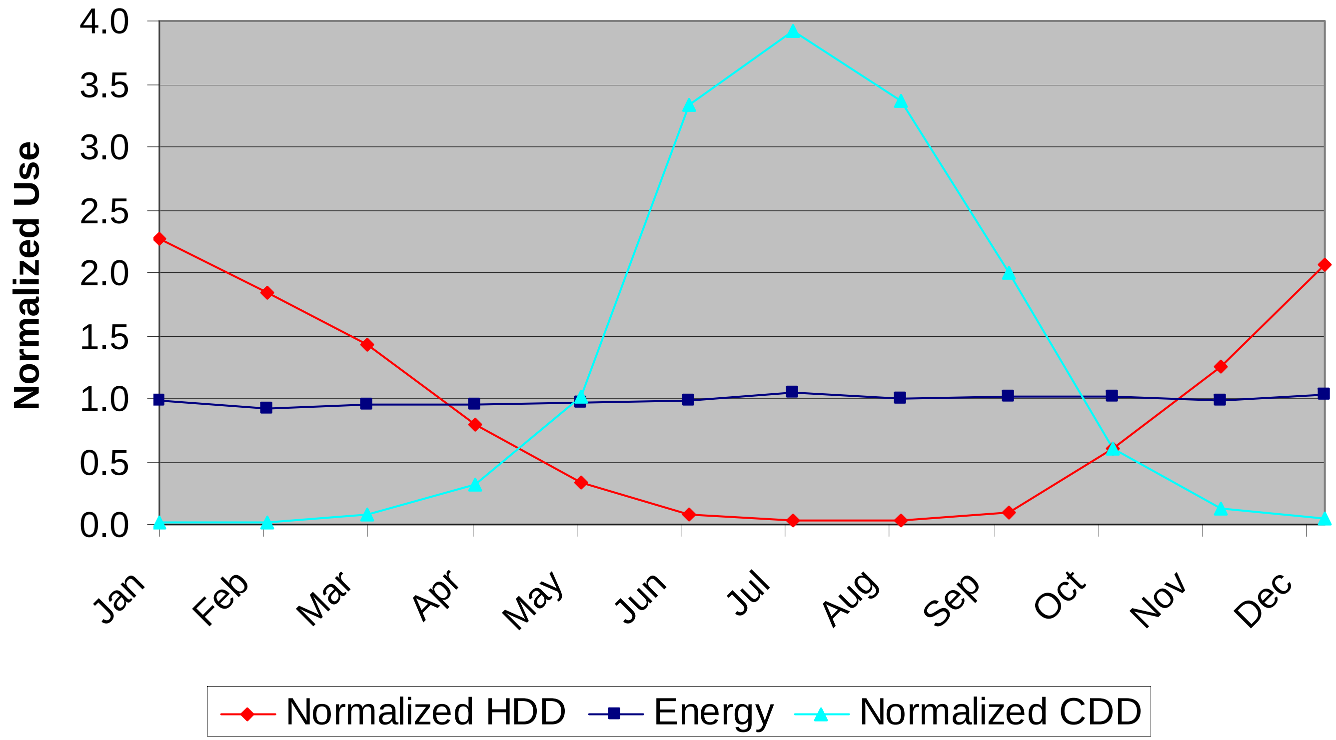
Monthly Energy Consumption 10 Warmest Climates

- Data Centers in 10 warmest climates show no variability in monthly energy consumption
- *12 buildings with annual CDD > 2400*



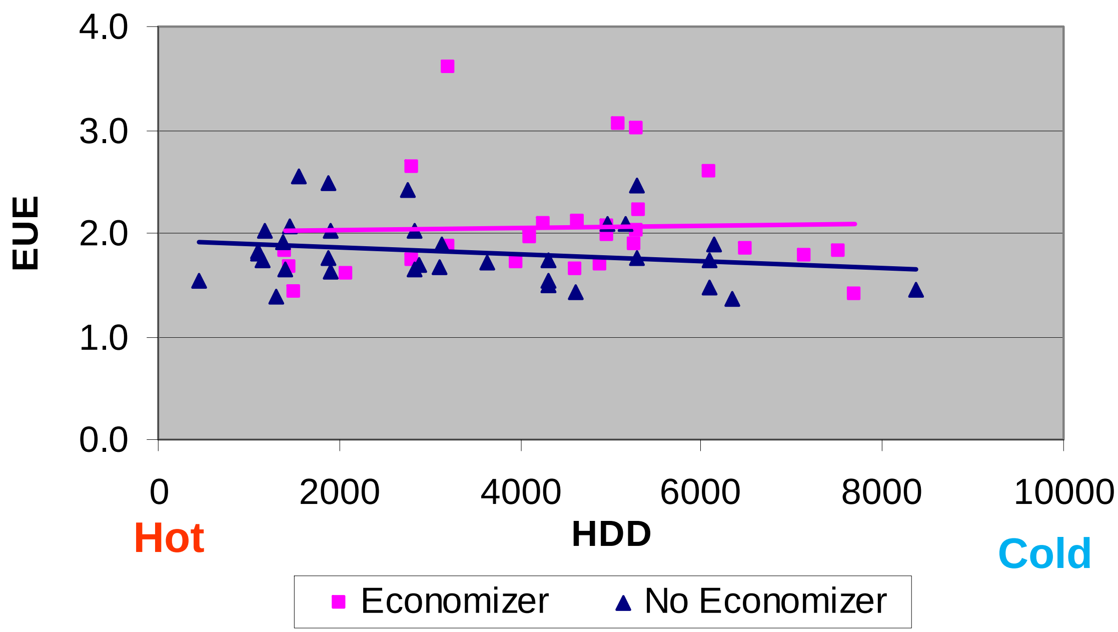
Monthly Energy Consumption All Standalone Data Centers

- Average of all Stand Alone Data centers shows no variability in monthly energy consumption



Economizers

- No Economizers: In cold climates (high HDD), EUE is lower than warm climates, as expected
- Economizers: In cold climates, EUE's are expected to be better than with no economizers, but not the case



Economizers do not appear to be working properly.

This result has been observed in other building types, where economizers can be disabled or prone to failure. The EPA rating can help identify operational problems.

Climate Conclusions

- No observed effect of climate on energy consumption
  - EUE not dependent on annual HDD or CDD
  - Monthly energy consumption shows little dependence on HDD or CDD for individual data centers in all climates
- Believed to be due to the fact that Internal loads are much higher than Climate loads
  - Reportedly a 10 to 1 ratio, much higher than commercial buildings
- EPA ratings adjust for ***observed*** relationships only
- *Heating and Cooling Degree Days are not likely to be included in a data center rating model*

Data Center Type

- Traditional and Hybrid have higher EUE's than Hosting and Internet
- Not enough data to draw conclusions for On-Demand, Telecom, and High Performance
- Generally not significant in regressions

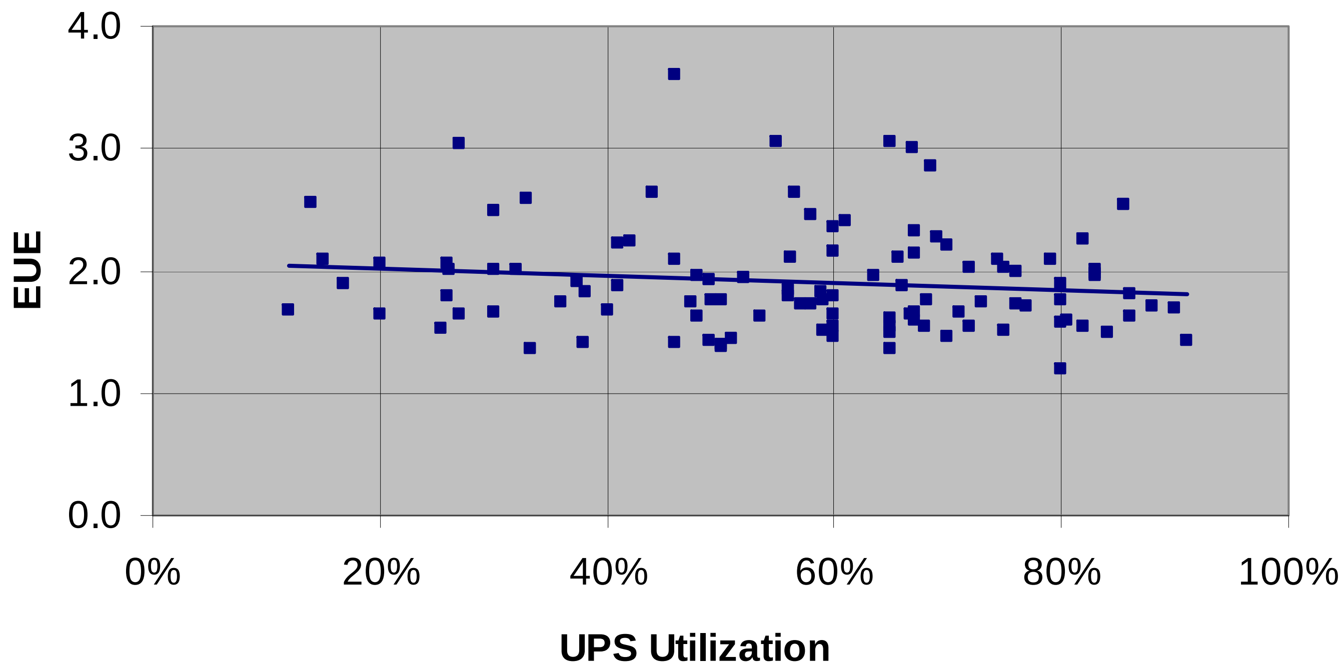
Data Center Type	Count	Percent	Average EUE
Traditional Enterprise	64	59%	1.97
Hybrid	12	11%	1.87
Internet	9	8%	1.79
Hosting	16	15%	1.77
On-Demand	3	3%	--
Telecom	3	3%	--
High Performance	1	1%	--
All Data Centers	108	100%	1.91

Data Center Type

- Conflicting theories exist for why certain data center types would have higher/lower EUE
  - Ex. Hosting: may have higher EUE due to less control over equipment specification
  - Ex. Hosting: may have lower EUE because data center operation is the primary business
- If there are no compelling reasons to include Data Center Type in a model, it would be best to exclude
  - Could be difficult for operators to classify data centers
  - Could result in gaming of the model
- *Question: Do you have any strong arguments for including a particular Data Center Type? Would excluding it result in bias against a particular type?*

UPS Utilization

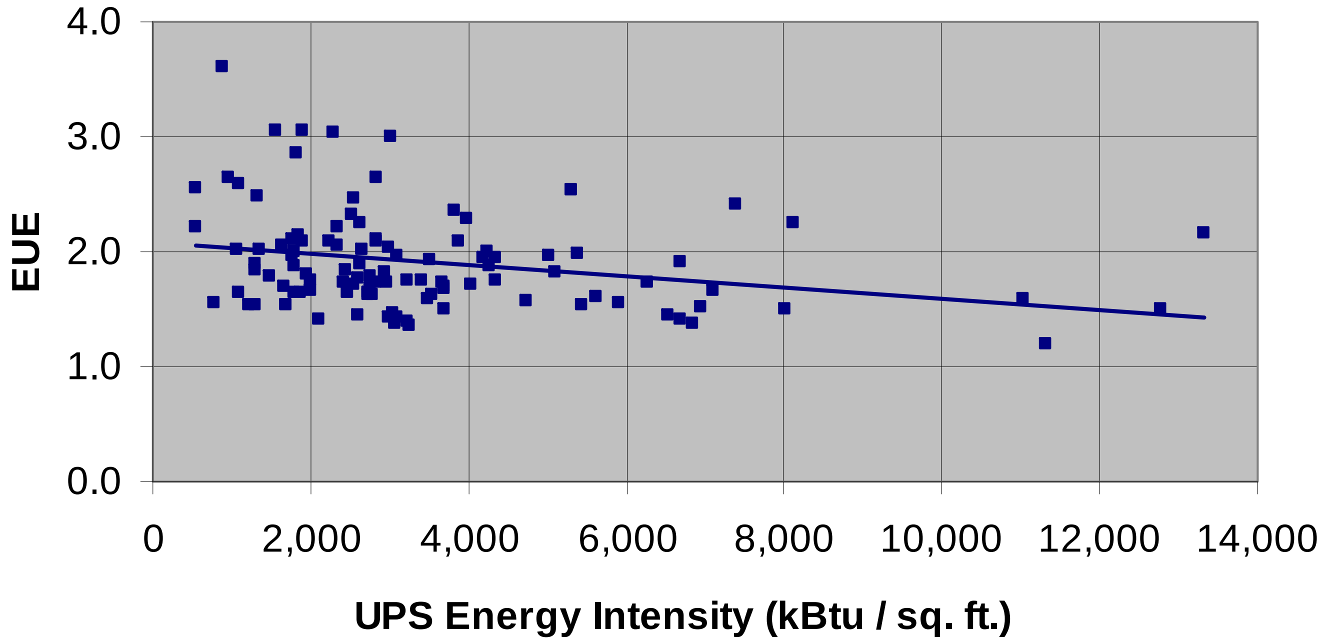
- EUE is slightly lower in buildings with high UPS Utilization, as expected
- Only significant in regressions if UPS Energy is excluded, but not nearly as strong as UPS Energy



Variables that ***May be*** Included in a Data Center Rating Model

UPS Energy Intensity (kBtu/Sq. Ft.)

- EUE is lower in buildings with high UPS energy intensity
- Consistently significant in regressions
- Dense arrangement of IT equipment likely results in more targeted (and efficient) cooling

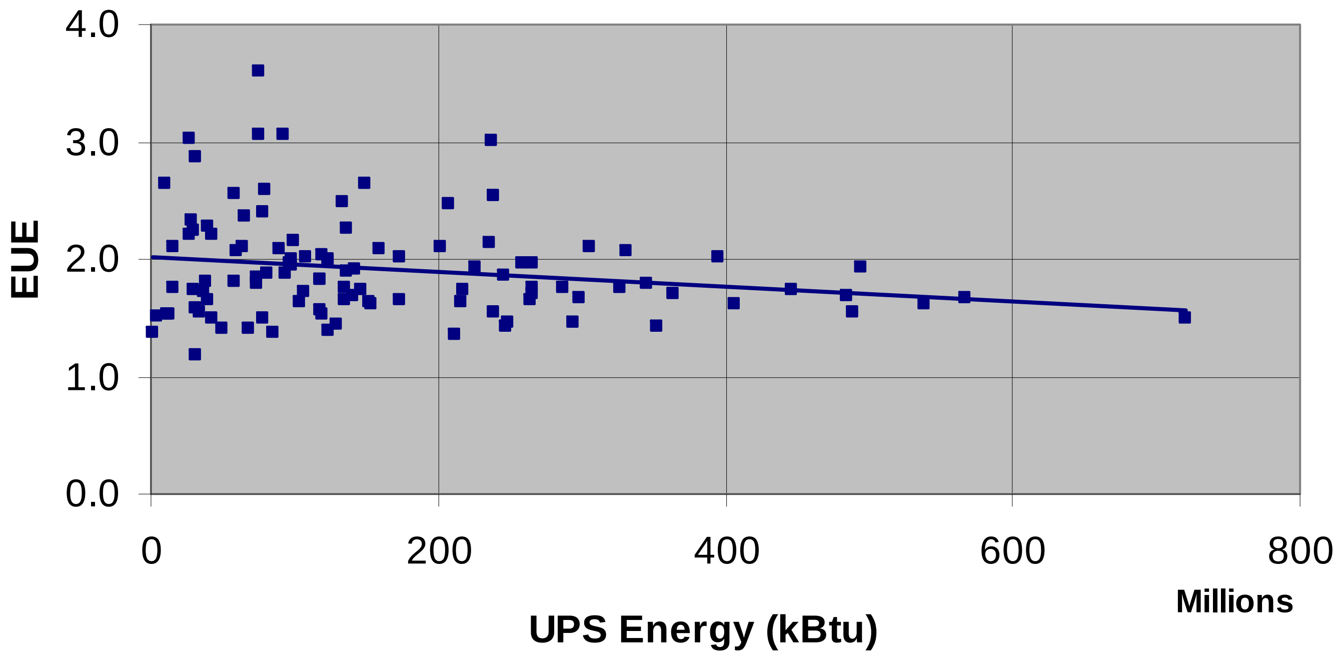


UPS Energy Intensity (kBtu/Sq. Ft.)

- EPA believes UPS Energy Intensity may be a type of "efficiency measure"
  - Dense arrangement of IT equipment results in efficient cooling
- If so, it should be ***excluded*** from the regression model
  - EPA models normalize for operational characteristics outside of an operator's control (Ex. Operating Hours for Offices)
  - EPA models do not normalize for efficiency measures (Ex. High efficiency lighting for Offices)
  - Buildings utilizing "efficiency measures" use less energy, and therefore receive higher ratings
- *Question: Do you agree with this assessment? Is density of IT equipment considered in design?*

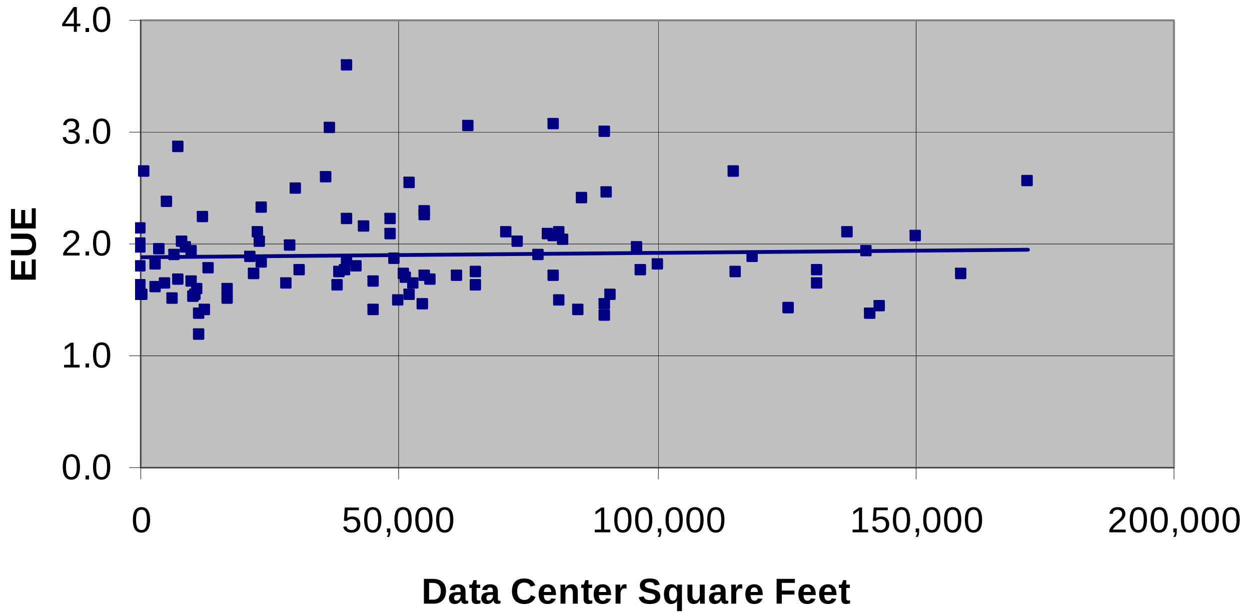
UPS Energy

- EUE is lower in buildings with higher total UPS Energy
- Consistently significant in regressions
- Likely due to economies of scale



Square Feet

- EUE is slightly higher in larger buildings
- Consistently significant in regressions
- Correlations exist between square foot, UPS Energy Intensity, and UPS Energy
- *Question: Do you have any theories as to why larger buildings would have higher EUE's?*



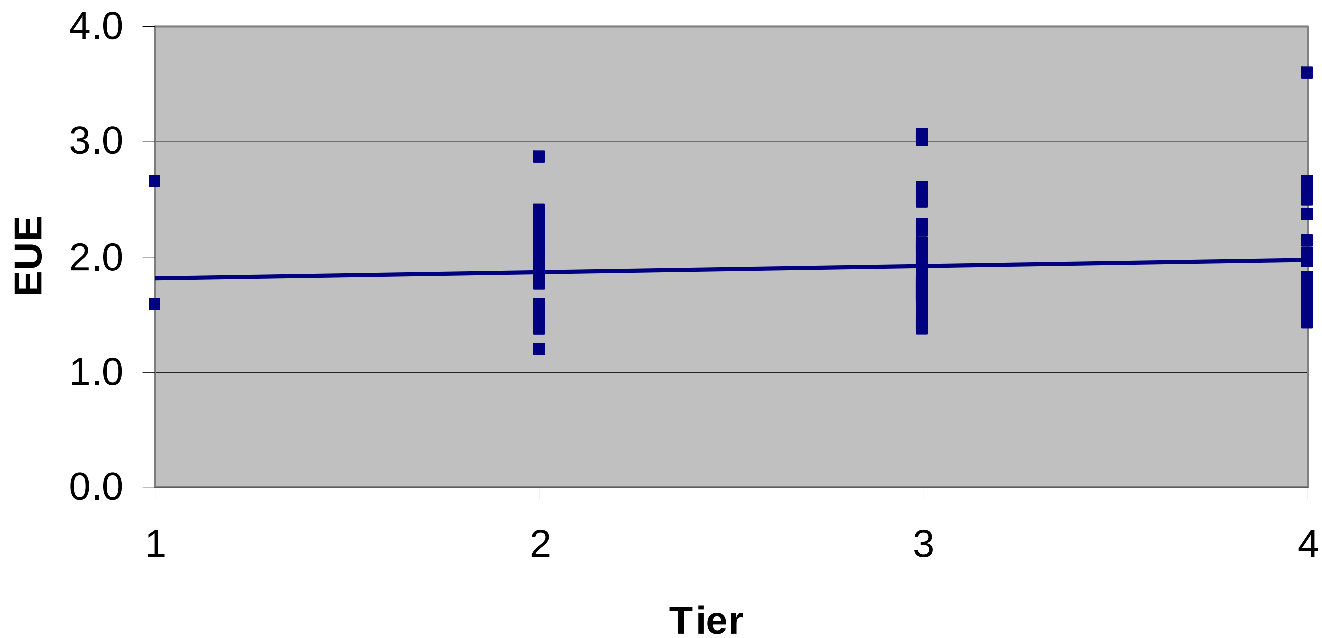
Tier

- Small differences in EUE across Tier levels
- Only two Tier 1 data centers, both are Enclosed
- High Tier (3 & 4) vs. Low Tier (1 & 2) distinction also being investigated

Tier level	Count	Percent	Average EUE
Tier 1	2	2%	--
Tier 2	27	25%	1.81
Tier 3	56	52%	1.92
Tier 4	23	21%	1.96
All	**108**	**100%**	**1.91**
Tier 1 & 2	29	27%	1.83
Tier 3 & 4	79	73%	1.94

Tier

- Slight positive trend line in graph of EUE vs. Tier
- Marginally significant in regressions
- Inclusion in models results in more consistent ratings for each Tier level



Model Selection Process

- Multiple factors to evaluate
  - Regression model statistics (F, p, R^2)
  - Individual variable statistics (t-stats)
  - Distribution of ratings
    - By 10% bin
    - Average rating
    - Number and percent above 75
    - By Data Center Type
  - Residual and rating plots
  - Physical understanding of results
    - Do variables make sense?
    - Industry feedback
  - Magnitude of impacts
    - How much does each variable affect the model?
- Best model must show a good balance using all criteria

EPA Findings

- With over 100 data centers, EPA has identified that there will be adequate data to support a 1-to-100 Rating
- The EPA rating will incorporate energy usage effectiveness (EUE)
  - Defined as Total Energy / UPS Energy
- The data show a strong correlation between EUE and total UPS energy
  - This effect will likely be included in the rating algorithm
- The data show a weaker correlation between EUE and Tier Level than anticipated
  - This effect is still being evaluated for inclusion in the rating algorithm
- Data centers do not exhibit a strong weather dependence

Next Steps

- By October 6, 2009
  - Submit comments regarding the analysis presented today
- November 2009
  - Webinar presenting additional results
  - Final model selected
- Spring 2010
  - Data center model scheduled for release

For More Information

Please send questions to:

ENERGYSTARdatacenters@icfi.com

Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters

ENERGY STAR®
Data Center Infrastructure Rating Development Update

Web Conference

November 12, 2009

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Agenda

- Welcome
- Rating Development Timeline
- EPA Rating Overview
- Response to Industry Feedback
- Proposed Rating Model
- Next Steps

Rating Development Timeline

- October 2007 – March 2008
  - Consultations with industry stakeholders
- March 2008 – June 2009
  - Data collection, Updates to industry
- June – September 2009
  - Analysis & Preliminary rating development
- September 29, 2009
  - Preliminary results presented to industry *(Recording available)*
- October – November 2009
  - Analysis of industry feedback & Final rating development
- April 2010
  - Data center model scheduled for release

Rating Development Objective

- Build on existing ENERGY STAR methods and platforms
- Apply to stand-alone data centers and data centers housed within office or other buildings
- Assess performance at the building level to explain how a building performs, not why it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)

Rating Development
EPA Methodology

- Express data center efficiency as an ENERGY STAR 1-to-100 rating
  - Each point on rating scale equals 1 percentile of data centers
- Adjust for operating constraints outside of the owner/operators control
  - Target efficiency will depend on operational constraints
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Preliminary EPA Findings Presented on September 29

- With over 100 data centers, EPA has identified that there will be adequate data to support a 1-to-100 Rating
- The EPA rating will incorporate power usage effectiveness PUE
  - Total Energy / UPS Energy
- The data show a strong correlation between PUE and total UPS energy; this effect will likely be included in the rating algorithm
- The data show a weaker correlation between PUE and Tier Level than anticipated; this effect is still being evaluated for inclusion in the rating algorithm
- Data centers do not exhibit a strong weather dependence

Industry Feedback

- Most comments received by EPA focused on:
  - Efficiency metric (PUE vs. EUE)
  - Source Energy
  - Use of UPS meter for IT Energy
  - Stand Alone vs. Enclosed Data Centers
  - Climate
  - Economizers
  - Tier level
  - Data Center Type (traditional, hosting, internet, etc.)
- Will provide more detail on each

Efficiency Metric: PUE vs. EUE

Issue: *EUE proposed as data center efficiency metric*

Industry Feedback: *PUE preferred over EUE*

- The name of the data center efficiency metric has been revised, but the value remains the same:

  Power Usage Effectiveness (PUE) = Total Energy / UPS Energy

- Total Energy includes all fuels (electricity, natural gas, diesel, etc.)

Efficiency Metric: PUE vs. EUE

- Why change to PUE?
  - EPA prefers to use an existing standardized metric
  - The name Energy Usage Effectiveness (EUE) had been considered to distinguish Total Energy from Total Electricity load
  - The use of ***Total Energy*** is consistent with the methodology detailed in Green Grid's white papers
    - PUE can be calculated using either energy or power
- Why use Total Energy?
  - This is consistent with all EPA rating models
  - For buildings that are 100% electric (most cases), a total energy metric is identical to an electricity metric
  - In cases where fuel is used (e.g. to power generators regularly or for absorption chillers) it is important to capture this load
  - For data centers enclosed in other buildings, note that Total Energy is the energy for the data center space only

Source Energy

Issue: *Source Energy required for rating calculations*
Industry Feedback: *Why is Source Energy necessary?*

- Source Energy is used for all EPA rating models
- It is the most equitable unit of evaluation to compare buildings with a diverse mix of fuel types
- It represents the total amount of raw fuel required to operate the building, and incorporates all transmission, delivery, and production losses
- A detailed description is available on the ENERGY STAR Web site

www.energystar.gov/ia/business/evaluate_performance/site_source.pdf

UPS vs. PDU Data

Issue: *IT Energy measured at UPS for rating model*

Industry Feedback: *Identified challenges that will require clear guidance*

- Why will the rating model be based on UPS data?
  - EPA wants data centers to be able to use the rating - only 35% of facilities in the data collection effort had PDU data available
  - EPA did not have enough PDU data to develop a rating
  - Results show limited losses between UPS and PDU readings
  - EPA prefers to issue clear and simple instructions to avoid confusion, to the extent possible
- Where will UPS data be measured?
  - EPA will request measurements at the output of the UPS meter

UPS vs. PDU data

- What if a data center doesn't have a UPS meter?
  - EPA will allow IT Energy to be measured at the PDU meter or at a location closer to the racks
- What if a data center has other equipment on the UPS meter?
  - If a data center has more than 10% non-IT load on a UPS meter, it will be required to measure IT Energy at the PDU meter or a location closer to the racks, or it can sub-meter the non-IT load
- What if a data center prefers to measure IT Energy at the PDU meter?
  - EPA may allow tracking of IT Energy at both the UPS and PDU meters, but the rating will be based on UPS data, because the rating model was developed with UPS data

Stand Alone vs. Enclosed

Issue: *EPA undecided on the use of Stand Alone facilities only vs. All data centers for model development*

Industry Feedback: *Confusion about applicability of model to Stand Alone vs. Enclosed data centers*

- Mix of Stand Alone and Enclosed data centers collected
- EPA will use Stand Alone facilities to develop the rating regression model
  - Energy performance ratings are similar regardless of data used
  - Overall significance of models is higher
  - Similar to process used by EPA for other space types
  - Greater confidence in IT Energy measurements for Stand Alone
- Portfolio Manager will calculate ratings for both Stand Alone and Enclosed data centers

Climate

Issue: *Climate variables not included in a rating model*
Industry Feedback: *Mixed response*

- Some respondents agreed that energy consumption is dominated by internal loads, as opposed to climate
- Others provided theoretical reasons why climate should influence load
- EPA does not dispute the fact that climate can have an impact on energy consumption
  - This impact is not significant enough to show up in the regression analyses that form the basis of EPA models
  - Variability in PUE as related to climate is less significant than variability caused by other factors (IT Energy, management, etc)
- EPA ratings must reflect ***observed*** relationships

Economizers

Issue: *Data shows little savings from economizers*

Industry Feedback: *The rating model should reward data centers that use economizers properly*

- The rating model will reward data centers that use economizers properly
- EPA models normalize for operational characteristics outside of an operator's control
- EPA models do not normalize for efficiency measures
- Buildings utilizing "efficiency measures" use less energy, and therefore receive higher ratings

Economizer Rating Example

- Two example buildings
  - Same UPS Energy, Size, Climate
  - Same Predicted PUE
  - Facility with economizer has lower Total Energy and Actual PUE
  - Different ratings

	No Economizer	With Economizer
UPS Energy (MBtu)	220,000	220,000
Total Energy (MBtu)	380,000	360,000
Predicted PUE	1.87	1.87
Actual PUE	***1.73***	***1.64***
Rating	***60***	***70***

Tier

Issue: *Tier under consideration for inclusion in a model*

Industry Feedback: *Tier should not be included*

- Facilities can have multiple Tiers within one data center
- Facilities may have unnecessarily high Tier levels thinking greater redundancy is better, even if it is not required for all components in the data center
- Normalizing for Tier level provides a disincentive for efficient design
- Based on industry feedback, Tier will not be included in the final model

Data Center Type

Issue: *Type expected to be excluded from model*

Industry Feedback: *General agreement*

- Many different categories of data center and even multiple categories within certain centers
- Operators agreed that the data (average PUE values, regression results) does not support the inclusion of data center type in a model
- Type will not be included in the final model

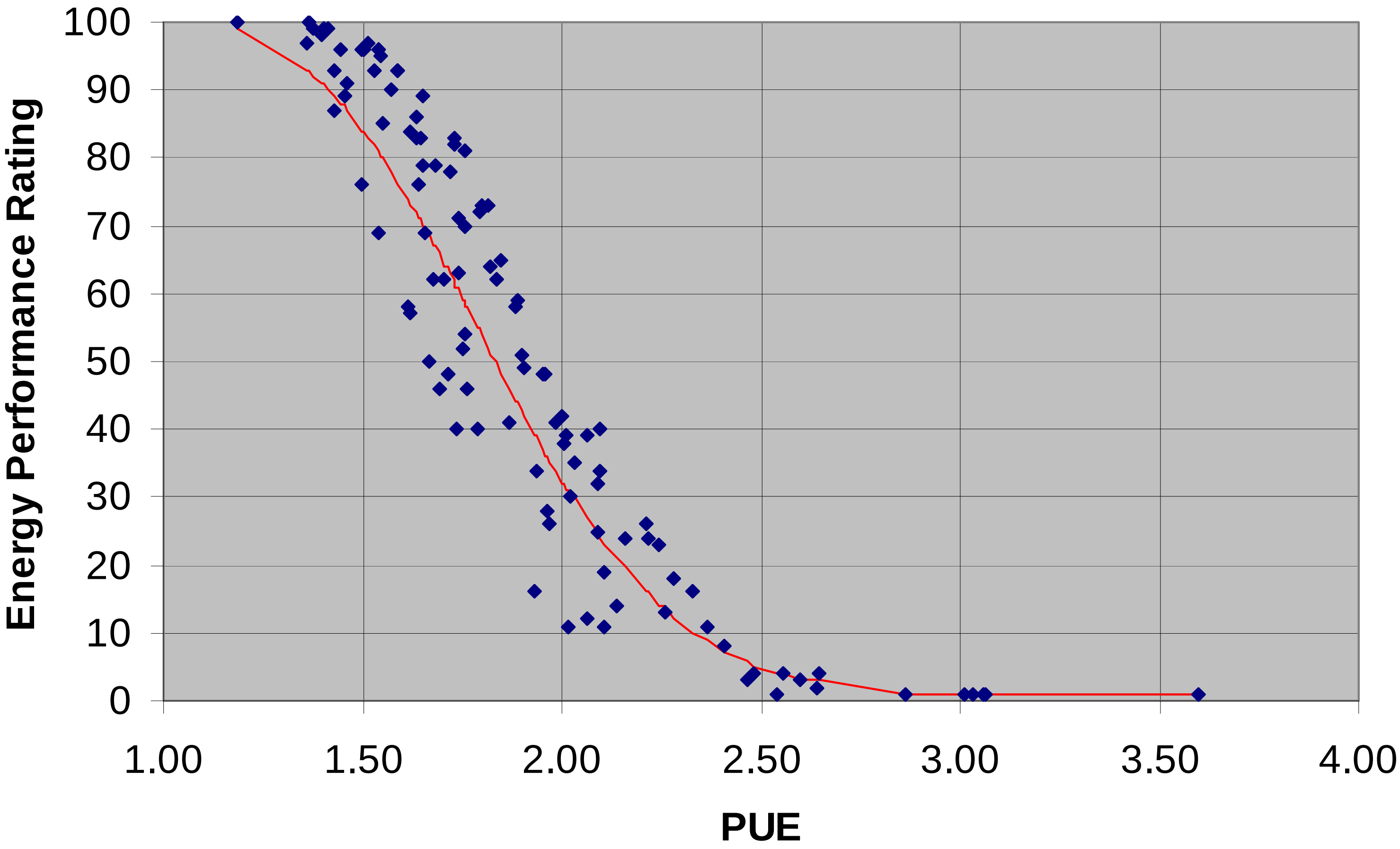
Model Recommendation

- Data: 61 Stand Alone Data Centers collected by EPA
- Dependent Variable: PUE
- Independent Variable: UPS Energy
- Overall Model Statistics
  - R-squared values are low (0.10) for a PUE model because UPS Energy explains a large percentage of Total Energy
  - R-squared values for a Total Energy model would be > 0.90
  - F-statistic: 7.56
  - P-level: .0079
- Individual Variable Statistics
  - The adjustment for UPS Energy is significant with 99% confidence
  - T-statistic is 2.75

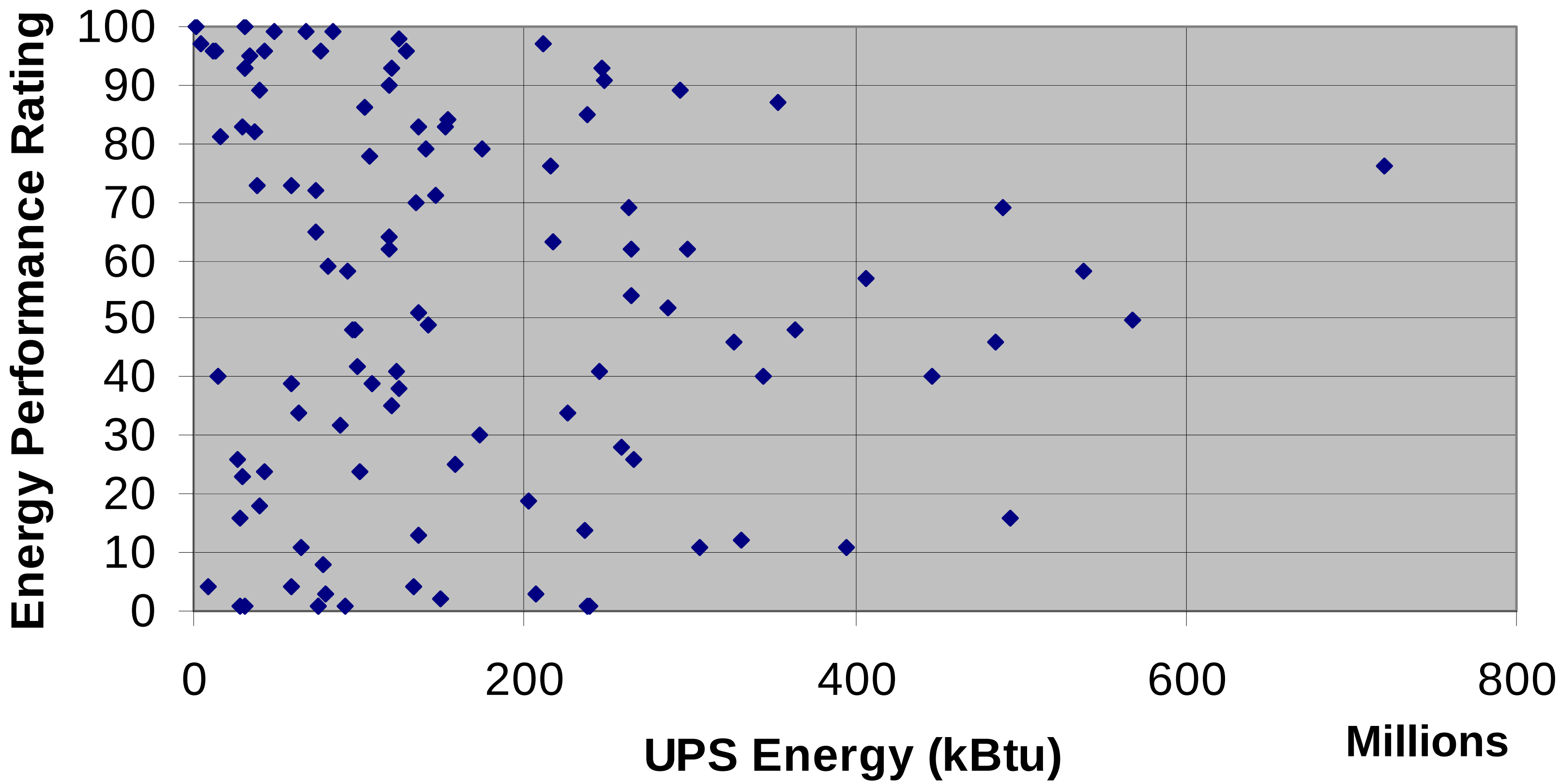
Model Performance

- Model produces appropriate ratings
  - Average Rating: 49
  - Percent Rating > 75: 23%
- Model produces a uniform distribution
  - Approximately 10% of the population falls within each 10 point rating bin
- Residual plots exhibit random scatter
  - Buildings with particular operating parameters do not have systematically higher (or lower) ratings
  - Buildings in different climates do not have systematically higher (or lower) ratings
- Strong model
  - Based on these results, the model appears robust

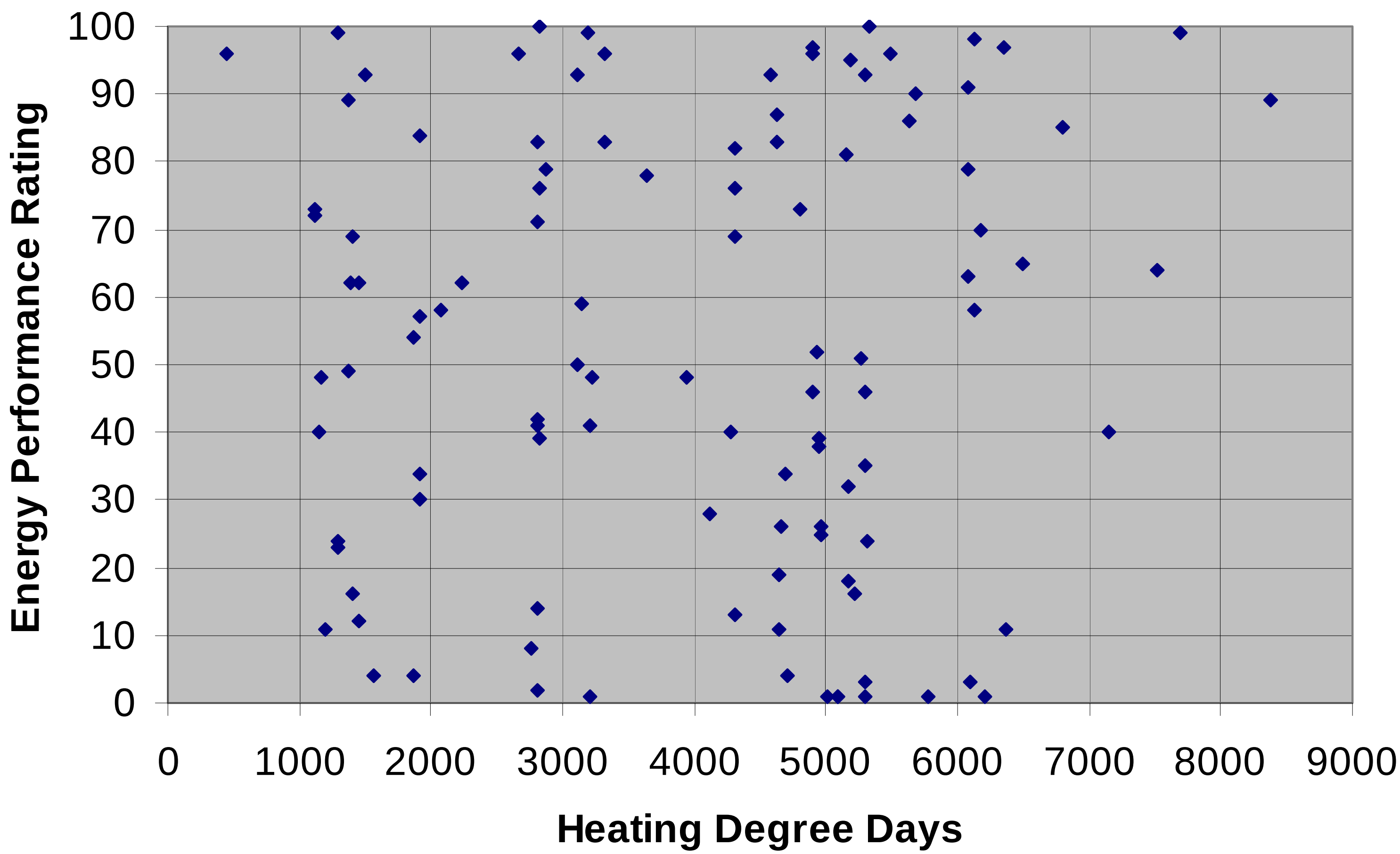
Rating vs. PUE



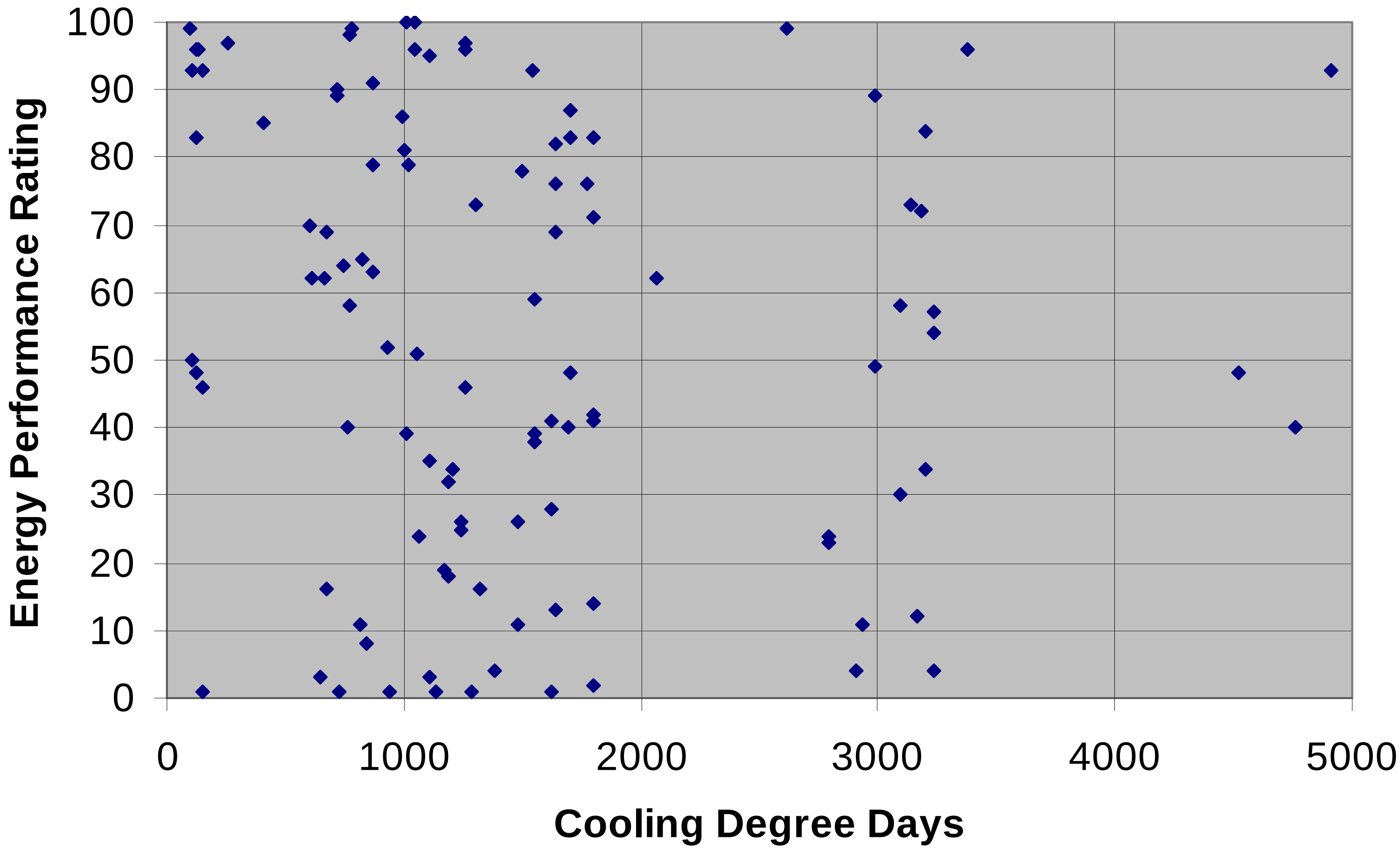
Rating vs. UPS Energy



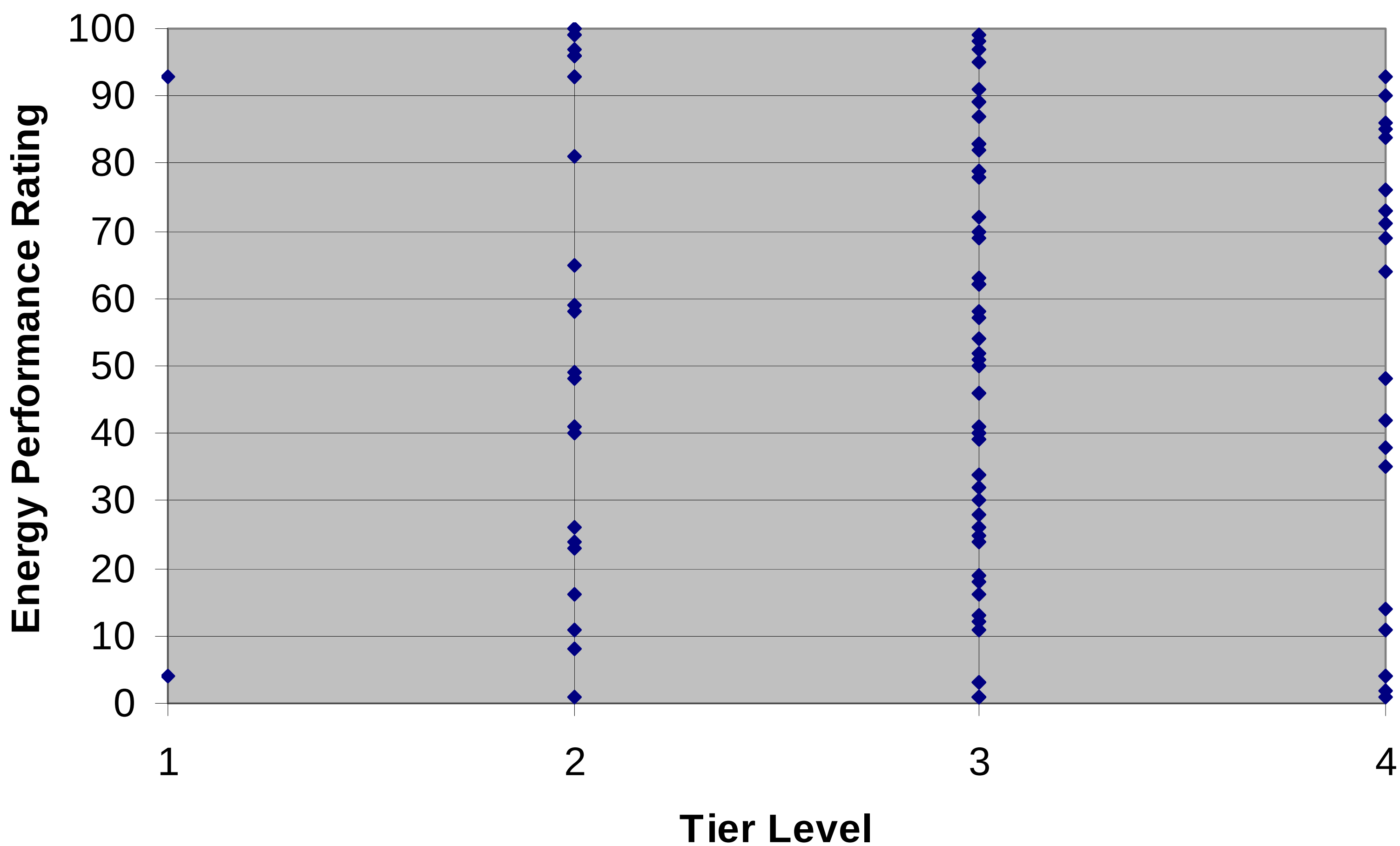
Rating vs. HDD



Rating vs. CDD



Rating vs. Tier



Summary

- Data collection
  - Developed data collection elements through a series of webinars with industry
  - Opened participation to any interested facilities
- Model development
  - Performed a thorough analysis of collected data – included a wide variety of operational parameters
- Solicited your feedback
  - Valuable insight into data center operations
    - Reasons why Tier and Type may not be significant
    - Observations about performance with respect to UPS and Climate
  - Incorporated your observations into final model variable decisions
- New model recommendation
  - Regression on PUE
    - Independent variable is UPS Energy
  - Good statistical properties
  - Equitable ratings for facilities in data collection

Next Steps

- By November 20, 2009
  - Submit comments regarding the results presented today
- November – December 2009
  - Final model selection
  - Preparation of software specifications
- January – March 2010
  - Software programming
  - Portfolio Manager training to prepare operators for model launch
- April 2010
  - Data center model scheduled for release

For More Information

Please send questions to:

ENERGYSTARdatacenters@icfi.com

Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters

New Data Center Rating Model
Direction for SRA
December 11, 2009

Objective

The purpose of this document is to outline the new requirements for generating a Data Center Rating. This will be a fundamental change to the current approach for Data Centers. The change will enable a rating to be calculated for a dedicated Data Center facility, and this rating methodology will be used to combine Data Center with all other space types. The new benchmarking methodology described herein should be applied with Portfolio Manager and Target Finder. As this is an existing space type, full integration with the automated benchmarking services (ABS) is essential. Additionally, relevant attribute information must be incorporated into the Data Warehouse, similar to building attribute information for other spaces. To ensure accuracy of development, EPA will need to see a score change report for all existing buildings with data centers, and EPA will provide a test spreadsheet of data centers to verify new calculations.

Timeline

Final Technical Direction to SRA	December 11, 2009
SRA/EPA Meetings to Discuss Changes	December 15 and 18, 2009
Score Change Report Delivered to EPA	TBD
EPA Approval of Score Change Report	TBD
Screenshot mockups for Training Delivered to EPA	TBD
Model Release in Portfolio Manager	April 15, 2010

EPA recommends scheduling as much time as possible for staging review, given the complexity of these enhancements

Sections

I. Attributes, Definitions, and Default Values

The new Data Center model will have a new, more explicit definition of a Data Center. The new model is intended for dedicated facilities, and should not be used for server closets. To perform the rating calculations, Portfolio Manager will require ***three attributes***. This section details the new definitions, attribute requirements, user entry requirements, and default considerations.

Data Center definition

Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data Center functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities. Often Data Centers are free standing, mission critical computing centers. When a data center is located within a larger building, it will usually have its own power and cooling systems. The Data Center space is intended for sophisticated computing and server functions; it should not be used to represent a server closet or computer training area.

Required attribute – Gross Floor Area

1. **Definition –** The total gross floor area is measured between the principal exterior surfaces of the enclosing fixed walls and includes all supporting functions for the Data Center. This should include the entire Data Center for stand alone facilities, which may have raised floor computing space, server rack aisles, storage silos, control console areas, battery rooms, mechanical rooms for cooling equipment, administrative office areas, elevator shafts, stairways, break rooms and restrooms. When a Data Center is located within a larger building, the total gross floor area should include the computing space as well as any mechanical rooms or office spaces that support the data center.

2. **Note –** This definition is similar to other definitions. For the Data Center audience it is critical to communicate that the entire data center (including mechanical rooms and offices) is part of the floor area, not just the computing/rack area.

3. **Model Calculation –** This term is **not involved** in the calculation of a rating. It is still required for the purpose of identifying the building type, computing a whole building EUI, computing weighted ratings, and other standard Portfolio Manager display metrics.

4. **Checklist Question –** Is this the total gross floor area measured between the principal exterior surfaces of the enclosing fixed walls, including all supporting functions for the Data Center? This should include the entire Data Center for stand alone facilities, which may have raised floor computing space, server rack aisles, storage silos, control console areas, battery rooms, mechanical rooms for cooling equipment, administrative office areas, elevator shafts, stairways, break rooms and restrooms. When a Data Center is located within a larger building, the total gross floor area should include the computing space as well as any mechanical rooms or office spaces that support the data center.

Required attribute – IT Energy Configuration

1. **Definition -** The IT Energy Configuration designates the location where the IT Energy consumption will be measured. The preferred location of this measurement is at the output of the Uninterruptible Power Supply (UPS) meter. Please refer to the definition of IT Energy for other meter locations which are permitted under certain conditions when UPS readings are not available.

2. **Note –**
   a. This attribute is a basic requirement for Annual IT Energy, and it requires its own input and data element in the database and warehouse.
   b. IT Energy Configuration shall be selected from a dropdown menu. The available Options are presented in **Table 1**.

3. **Model Calculation –** This attribute is not directly involved in the calculation. However, the designation of IT Energy Configuration will identify whether a UPS Output Meter or PDU Input meter is required (refer to User Entry Requirements in **Table 2**). Thus, this variable must be referenced in order to pull the correct meter data into the rating.

4. **Checklist Question –** The checklist should display the dropdown menu selection. The question will depend on which option has been selected, as summarized in **Table 1**.

Table 1
Summary of Checklist Questions for IT Energy Configuration

Option	Drop Down Menu Description	Question
1	Uninterruptible Power Supply (UPS) Meter supports only IT Equipment.	Does the UPS meter support only IT equipment within the Data Center?
2	UPS Meter includes non-IT load of 10% or less	Does the UPS meters support all IT load at the Data Center along with minimal non-IT loads, which account for 10% or less of the total UPS load?
3	UPS Meter includes non-IT load greater than 10%. Non-IT load is sub-metered.	Does the UPS meter support a combination of IT and non-IT loads, where the non-IT loads account for more than 10% of the total UPS load, and are separately sub-metered?
4	UPS Meter includes non-IT load greater than 10%. Non-IT load is **not** sub-metered.	Does the UPS meter support a combination of IT and non-IT loads, where the non-IT loads account for more than 10% and are not separately sub-metered?
5	Facility has no UPS Meter.	Does this facility have ***no*** UPS system to provide power to IT equipment?
6	IT Energy is not currently metered at this facility – Apply defaults.	Is there inadequate metering at this facility to measure IT energy consumption at either the Output of the UPS or Input of the PDU?

Required attribute – Annual IT Energy

1. **Definition –** The IT Energy is defined as the total amount of energy required by the server racks, storage silos, and other IT equipment in the Data Center. For the purposes of ENERGY STAR this should be measured at the output of the Uninterruptible Power

Supply (UPS). A measurement of IT Energy from the UPS output is consistent with a Level I measurement of data center Power Usage Effectiveness, or PUE.

a. These measurements should be taken as energy readings, in kWh. They should not be instantaneous power readings. Input fields permit readings for a user-determined measurement time period (e.g. weekly, monthly, or quarterly). Monthly measurements are recommended, roughly on schedule with utility readings, if possible.
b. Facilities that do not have a UPS meter are permitted to supply readings from a Power Distribution Unit (PDU) or alternate location. In these cases, readings should be made from the input of the PDU meter, or the first available measurement point. For consistency, if the measurements are available at the PDU input, they should be reported in favor of rack-level or other measurements.
c. Facilities for which more than 10% of the UPS load is directed to non-IT (e.g. mechanical) equipment are required to provide a reading that excludes the non-IT equipment. Two options are permitted:
    i. If energy used by non-IT equipment is measured, then it may be subtracted from the total UPS energy, and the remainder should be entered into the UPS Output Meter in Portfolio Manager
    ii. If energy used by non-IT equipment is not measured, then supply a reading from the input to the PDU meters that support the IT equipment.

2. **Notes –** IT Energy is a new concept and it will be unlike any other existing attribute, because users must be able to enter ***monthly entries***, not just a single entry. Although it is more complicated than a standard attribute, the entire definition presented above should be listed. Please refer to the following sections on User Entry Requirements for information on how this attribute will be entered.

3. **Model Calculation –** The model will incorporate the ***Annual IT Energy***.
    a. <u>Computing Annual IT Energy</u> – The model is based on the Annual IT Energy use. This should be computed by summing up the IT meter entries for the twelve month period of evaluation.
        i. Per the IT Energy Configuration, a given building may have a UPS Output Meter, a PDU Input meter, or both. Portfolio Manager should compute the annual energy for the PDU meter entries and the UPS meter entries separately. That is, there should be an ***Annual PDU Input Energy*** (in Site kWh) and an ***Annual UPS Output Energy*** (in Site kWh). Depending on the specific elements entered, a particular data center may have one or both of these options.
            1. It should be possible to borrow from existing energy meter code so that IT Energy can be computed for each month and therefore for each 12 month period of interest, across a given set of meters.
        ii. Both the Annual PDU Input Energy and the Annual UPS Output Energy will be available for display in the new metrics (refer to separate section on new metrics)
        iii. ***Only one metric*** will be important for the model calculation. This will be the measure that was required, per the direction in ***Table 2***. The annual

value for the required metric should also be stored as the ***Annual IT Energy*** (in Source kBtu).

1. Site kWh * (3.412kBtu/kWh) * (3.34Source/Site) = Source kBtu

b. Energy Alerts for Annual IT Energy – A building should be required to have valid Annual IT Energy data in order to generate a rating.

   i. It will be necessary to apply existing energy meter requirements to the new IT meters (e.g. no gaps or overlaps of more than 1 day).

   ii. A new eligibility requirement should require 12 months of IT Energy data that correspond to the 12 months of energy data for the building.

c. Model Calculations with Annual IT Energy – The model incorporates the Annual IT Energy in two ways:

   i. The dependent unit of analysis will be defined as the Power Usage Effectiveness (PUE).

      1. PUE = Total Annual Source Energy (kBtu) / Annual IT Energy (in Source kBtu)

   ii. Annual IT Energy (in Source TBtu) will also appear as an independent variable in the calculation.

      1. Note this is in ***Source TBtu*** (1 TBtu = 10^9kBtu)

4. **Checklist Questions –**

   a. The checklist should display a table of values for all PDU and UPS monthly meter readings (both required and optional meters), where optional meters should be identified as optional.

   b. The ***total across all required meters*** should be added together (i.e. the Annual IT Energy consumption), and displayed. Along with the following questions:

      i. Does this total IT Energy reflect the total IT load at the Data Center in accordance with the EPA metering requirements? EPA metering requirements are for a meter at the output of the UPS meter.

         1. Facilities that do not have a UPS meter are permitted to provide readings from the input of the PDU

         2. Facilities for which more than 10% of the UPS load is directed to non-IT equipment are permitted to subtract the non-IT loads if they are sub-metered, or to report a reading from the PDU if the non-IT loads are not sub-metered

User entry requirements – Add Space

Because of the unique attributes for Data Center, the entry screen will have to differ from the standard used for other space types.

1. Add Space Page Summary – When the user first lands on the Add Space page, they should see three tables, as shown in **Attachment A.1**.

   a. Gross floor Area Table – Should be a free response field with units of square feet (Sq. Ft) or square meter (Sq. M)

b. IT Energy Configuration Table– Should be presented as a dropdown menu with the following options (given the amount of space, these values should be able to fit in a dropdown menu. EPA is open to other formats):
    i. Uninterruptible Power Supply (UPS) Meter supports only IT Equipment. ***(preferred)***
    ii. UPS Meter includes non-IT load of 10% or less.
    iii. UPS Meter includes non-IT load greater than 10%. Non-IT load is sub-metered.
    iv. UPS Meter includes non-IT load greater than 10%. Non-IT load is not sub-metered.
    v. Facility has no UPS Meter.
    vi. IT Energy is not currently metered at this facility – Apply defaults.

c. IT Energy Meters Table – This table should be similar in function to the general Add Meters table for a building. It will allow a user to store PDU and/or UPS meters.

d. Optional attributes are still under consideration. If EPA decides to include some, they will be included following the IT Energy Meters table.

2. Step 1 (user): Floor area and IT Configuration – The first step will be for the user to enter the Gross Floor Area and the IT Energy configuration.
    a. As shown in **Attachment A.1**, the text in the IT Energy Configuration table will update based on the user entry, in order to identify which type of IT meter is required for benchmarking. **Table 2** summarizes the required and eligible meters associated with each option.
    b. If Option 6 (Apply defaults) is selected then the user will be finished. For all other options, the user will proceed to Step 2.
        i. Note that this option for defaults will be a ***temporary option*** that will be included in Portfolio Manager for the first 2 years only (until April 2012). Refer to the subsection on Default Values for more information.

Table 2
Summary of Optional and Required Elements based on IT Energy Configuration

Option	Description	UPS Meter	PDU Meter
1	Uninterruptible Power Supply (UPS) Meter supports only IT Equipment.	Required	Optional
2	UPS Meter includes non-IT load of 10% or less.	Required	Optional
3	UPS Meter includes non-IT load greater than 10%. Non-IT load is sub-metered.	Required	Optional
4	UPS Meter includes non-IT load greater than 10%. Non-IT load is **not** sub-metered.	Optional	Required
5	Facility has no UPS Meter.	NA	Required
6	IT Energy is not current metered at this facility – Apply Defaults.	NA	NA

3. Step 2 (user): Add IT Energy Meter – The user should be able to add one or more IT Energy meters. This should proceed similar to adding an energy meter, except there are fewer options. The first screen associated with the Add Meter page is presented in **Attachment A.2**

    a. Enter Meter Name – This should be a free response field (String).
    b. Select Meter Type – This should be a dropdown menu, from which the user can select UPS Output Energy or PDU Input Energy
    c. Meter Entries to Add – A dropdown menu to allow the user to select a number of entries, ranging from 1 to 12.
    d. Start Date – A entry field for a start date in MM/DD/YYYY format.
    e. Energy Type – This will be fixed at Electricity
    f. Units – This will be fixed in kWh
4. Step 3 (user): Specific IT Energy Values – Once the user has entered the type of IT Energy meter and the number of entries, they will be taken to a screen to add specific meter entry values. The basic table structure should be similar to the table used to add energy meter entries, except there is no column for a cost figure. A user should be able to enter multiple entries with specified start and end dates. **Attachment A.3** presents sample IT Energy Meter Entry Tables.
5. Step 4: (system): Identify and Store Annual IT Energy – Based on the fields entered under steps 2 and 3, a specific data center space may have data in a PDU meter, a UPS meter, or both. The model is based on Annual IT Energy. As such, a separate field should be created and stored in the database and data warehouse. This field is the ***Annual IT Energy***. This should reflect the 12 month sum across the required IT Energy meters (UPS or PDU). This means that there will be three fields in the database and data warehouse:
    a. Annual PDU Input Energy (in Site kWh)
    b. Annual UPS Output Energy (in Site kWh)
    c. Annual IT Energy (in Source kBtu)
6. Note: Multiple IT Energy Meters – A user should be able to enter multiple UPS or PDU meters. This should affect calculations as follows:
    a. All UPS meters should be added together to generate Annual UPS Output Energy
    b. All PDU meters should be added together to generate Annual PDU Input Energy
    c. All meters of the required type (UPS or PDU) should be added together to get the Annual IT Energy (in Source kBtu)
    d. 12 months of data shall be required to receive a rating ***for all meters of the required type (UPS or PDU)***.

User entry requirements – Edit Space

Once a user already has a Data Center space, if they select that space from the main Space Use table (on the My Facility Page), then they should be able to see and edit all attributes, including the IT Energy. A proposed screen shot of the Edit Data Center Space page is presented as **Attachment A.4.**

1. Edit Gross Floor Area – Can be edited using correct or update, per standard attribute functionality.
2. Edit IT Configuration – Can be edited using the correct or update feature, per standard attribute functionality
    a. When Edit IT Energy Configuration is selected, the next screen can look similar to the table to enter IT Energy Configuration in **Attachment A.1**. The user will

select one of the IT Energy Configuration options, and the resulting instructions on the required and optional IT Energy fields will be displayed.

b. ***Note that a change to this element could change the required IT Energy field from UPS to PDU or vice versa***. In this case, the revision history should be kept and this will simply change which meter values (PDU or UPS) are stored in the Annual IT Energy.

   ii. For example: A building has Option 5 selected and enters PDU data for the calendar year 2009. In January 2010, they change to Option 1 and add a UPS meter. When they want a rating for June 2010, the IT Energy should reflect the PDU Meter for July 2009 through December 2009, and the UPS Meter for January 2010 through June 1010.

c. The revision history for this element must log the date for a given change to IT Energy Configuration to ensure that the correct meter (UPS or PDU) is recorded as the IT Energy, per the preceding example.

d. If an IT Energy Configuration is selected that will result in an NA rating, a pop-up window will be displayed with the following text: "If you continue to save with the entered IT Energy Configuration, this space will not have the required IT Energy Meters to obtain a rating. The required IT Energy Meters can be added to generate a rating, or a different IT Energy Configuration can be chosen. Select OK to continue with the Save; select Cancel to make changes." This is similar to the pop-up window that currently displays if edited space attributes result in NA ratings.

3. Edit IT Energy – IT Energy meters should be edited according to the same protocol used for energy meters in Portfolio Manager. Clicking on the meter name should reveal a table of values. These tables can be edited directly, or new monthly entries can be added.

User entry requirements – Target Finder

Given the special user entry requirements for the Data Center space attributes, the implementation bears some additional direction. For the purpose of Target Finder, it would not be necessary to provide monthly meter entries for IT Energy. When Data Center is selected in Target Finder, the following attributes should appear, each with a single field. This option is shown in **Attachment A.5**

1. **Gross Floor Area –** Blank field for a single value in Sq. Ft.
2. **Estimated Annual IT Energy –** Blank field for a single annual value in kWh

Separate text will be developed for Target Finder Help to explain that Annual IT Energy should be estimated as part of the design, and should be analogous to the equipment IT load that will be on the UPS (i.e. UPS output).

Optional attributes

As discussed in the preceding section, most users will have an option to enter a second measure of IT Energy. Users will be able to enter PDU Input Energy and/or UPS Output Energy.

Depending on their equipment configuration, one of these meters will be required while the other will be optional.

EPA will incorporate two additional Optional Attributes. These should appear on the Add Space Page in their own table, below the IT Energy Meters Table. They will be standard attribute format (e.g. single response items, not monthly entries). The two optional attributes are as follows:

1. **UPS System Redundancy**
    a. Definition – Redundant components are typically required to accommodate IT loads in the event of equipment failure. The specific level of redundancy will depend on the Data Center and its particular functions. Please select the redundancy level that best applies to the Uninterruptible Power Supply (UPS) at the Data Center. If there is no UPS system, indicate the redundancy for the PDU Meters that support the IT load. If there are multiple systems operating at different levels of redundancy, choose the option that applies to the majority of the IT load.
    b. Dropdown Menu Options – This question should have a dropdown menu with the following options:
        i. N
        ii. N+1
        iii. N+2
        iv. 2N
        v. Greater than 2N
        vi. None of the Above
    c. Data Checklist Question – Is this the level of redundancy of the Uninterruptible Power Supply (UPS). If there is no UPS system, is this the redundancy for the PDU Meters that support the IT Load?

2. **Cooling Equipment Redundancy**
    a. Definition – Redundant components are typically required to accommodate the Data Center in the event of equipment failure. The specific level of redundancy will depend on the Data Center and its particular functions. Please select the redundancy level that best applies to the mechanical cooling equipment. If there are multiple systems operating at different levels of redundancy, choose the option that applies to the majority of the data center cooling load.
    b. Dropdown Menu Options – This question should have a dropdown menu with the following options:
        i. N
        ii. N+1
        iii. N+2
        iv. 2N
        v. Greater than 2N
        vi. None of the Above
    c. Data Checklist Question – Is this the level of redundancy for the mechanical cooling equipment at the Data Center?

Attributes to be removed

The attribute **Weekly Operating Hours** is currently required for the secondary space Computer Data Center. It will not be required for the new model, and should be removed from the tool.

Default values

Ultimately default values will not be permitted for this model. Gross Floor Area is never allowed to have a default in Portfolio Manager. For the Data Center model, Annual IT Energy is the most important factor, and it is in many ways equivalent to Gross Floor Area in the other models. As such, it is not logical to permit default values.

However, defaults will be permitted for the first two years of implementation (until April 2012). Defaults will be allowed temporarily because current Portfolio Manager users with Data Centers may not have proper metering in place to provide either UPS or PDU readings. In order to provide continuity for these users, default values will be available for 2 years. After that time, defaults will not be permitted.

When a default is selected, the calculation methodology will be completely different, in this case it will be ***treated as a secondary space***. This means ***it will still be limited to 10% of the total floor area***. In these situations, the Data Center predicted source energy use will be ***subtracted*** from the actual source energy of the building prior to computing and looking up the efficiency ratio (or actual source energy) in the lookup table.

In this approach the predicted energy for the Data Center as a default space will not use the new model, nor it will use the old assumptions in Portfolio Manager. The new default engineered adjustment is as follows:

- Predicted Source EUI = 2,000 kBtu/ft^2
- Predicted Source Energy = 2,000 kBtu/ft^2 * Data Center Gross Floor Area
- The predicted source energy will be subtracted from the ***actual*** source energy use of the building. The resulting value (actual – Data Center) will be used to rate the rest of the building
- If a data center uses defaults, it must be 10% or less of the floor area
    - If it is more than 10%, then the rating should be N/A
- As with any secondary space, this methodology can result in a negative value for actual source energy consumption. This result is not expected to be common. However, it is possible. If a negative value is obtained for the actual source energy, the building should be assigned an actual source energy value of zero, and therefore the building should receive ***an energy performance rating of 100***. SRA should maintain a list of these buildings and their operating characteristics, and present this list to EPA on a quarterly basis.

Starting on ***April 15, 2012***, defaults will no longer be permitted. This means that buildings with data centers may currently have ratings going back to 2000. However, if they do not have UPS or PDU data back to this year, they will not be able to receive a baseline rating for 2000 after April 15, 2012. EPA will develop guidance to prepare for this change. If a desired change to this policy decision is required it will be planned and documented along with the official April 2012 release guidance.

Recoding Requirements for existing data centers

The following re-code actions should apply to all existing data centers:

1. Gross Floor Area – The Gross Floor Area is already required for the secondary space Computer Data Center. This value should remain as the Gross Floor Area attribute for the new Data Center space.
2. IT Energy Configuration – All exiting buildings should be defaulted to Option 6 (I do not have any IT measurements – Apply defaults)
    a. ***Is it possible to provide a pop-up or other message to existing Portfolio Manager users to direct them to this new requirement?***
3. It Energy – Because all Data Centers will be coded to use defaults, there is no need to establish IT Energy meters within these buildings on April 15, 2010.

II. New Metrics and Views for Data Centers

The following ***seven new metrics*** should be available via Create View. With the exception of the National Average PUE, each should be available for both Current and Baseline years, for a total of ***thirteen*** new custom view entries. These thirteen new Create View entries should appear in their own new section, ***Data Center Metrics***. For facilities that do not have Data Center, these metrics would display as N/A. For facilities with Data Center, they should be computed as follows:

- **Site UPS Output Energy** (kWh) **–** This should compute the annual value for the UPS energy for the specified twelve month period. The value is presented in kWh. This metric should be available for both Current and Baseline time periods.
    - If the facility does not have a UPS meter for ***all*** data center spaces in the facility, this should be N/A
    - If the facility does not have twelve months of UPS data, this should be N/A
- **Site PDU Input Energy** (kWh) **–** This should compute the annual value for the PDU energy for the specified twelve month period. The value is presented in kWh. This metric should be available for both Current and Baseline time periods.
    - If the facility does not have a PDU meter for ***all*** data center spaces in the facility, this should be N/A
    - If the facility does not have twelve months of PDU data, this should be N/A
- **Source IT Energy** (kBtu) **–** This should compute the annual value for the IT Energy for the facility. This metric should be available for both the current and baseline time periods.
    - IT Energy will be a function of the required IT Energy for the facility (UPS or PDU energy)
    - If the facility is using default values for IT Energy this will be NA.

- If a building has multiple Data Center spaces, this may include adding PDU meters values from one space, with UPS meter values for the other space. All required IT Energy meters should be included.

- **PUE-UPS Output**– This should be computed as shown below. This metric should be available for both the current and baseline time periods.
  - PUE-UPS Output = Total Source Energy (kBtu)/UPS Source Energy (kBtu)
  - To compute the UPS source energy:
    - UPS Site kWh * 3.412 kBtu/kWh = UPS Site kBtu
    - UPS Site kBtu * 3.34 (Source kBtu/Site kBtu) = UPS Source kBtu
  - This ratio does not have any units (source kBtu/source kBtu)
  - If there are ***any space types*** other than Data Center in the building, this should be N/A, because the total energy does not correspond to the data center.
  - If the facility does not have a UPS meter for all data center spaces in the facility, this should be N/A
  - If the facility does not have twelve months of UPS data, this should be N/A
- **PUE-PDU Input –** This should be computed as shown below. This metric should be available for both the current and baseline time periods.
  - PUE-PDU Input = Total Source Energy (kBtu)/PDU Source Energy (kBtu)
  - To compute the PDU source energy:
    - PDU Site kWh * 3.412 kBtu/kWh = PDU Site kBtu
    - PDU Site kBtu * 3.34 (Source kBtu/Site kBtu) = UPS Source kBtu
  - This ratio does not have any units (source kBtu/source kBtu)
  - If there are ***any space types*** other than Data Center in the building, this should be N/A, because the total energy does not correspond to the data center.
  - If the facility does not have a PDU meter for all data center spaces in the facility, this should be N/A
  - If the facility does not have twelve months of PDU data, this should be N/A
- **Data Center Source PUE –** This should be computed as shown below. This metric is required because it is the PUE that is actually used in modeling, and it is available for any building that includes only Data Center space. This metric should be available for both the current and baseline time periods.
  - Data Center PUE = Total Source Energy (kBtu)/Annual Source IT Energy (kBtu)
  - The ratio does not have any units (source kBtu/source kBtu)
  - If there are ***any space types*** other than Data Center in the building, this should be N/A, because the total energy does not correspond to the data center.
  - If there are not twelve months of Annual IT Energy, this should be NA.
- **National Average PUE**
  - For facilities with only Data Center spaces this is the PUE that will give a rating of 50
    - This is analogous to the National Average Source EUI presented for rated buildings.
  - For facilities with multiple space types, this is the national average PUE
    - For buildings with multiple space types present, this should present as the mean source PUE, which is 1.924
    - ***National Average PUE = 1.924***

Another new metric should be added, within the Source Energy section, for all building types:

- **Current Total Source Energy Use (kBtu)** – As it sounds, this metric should be the total source energy of the building in kBtu. This metric is relevant for all buildings, and should have been incorporated into Portfolio Manager sooner. But, it is especially important for this audience, so now is an appropriate time to add it.

The National Average Source EUI is an existing metric that can ***continue to be shown*** for both buildings with only Data Center space, as well as buildings that have a combination of Data Center and other space types. This metric displays the source energy associated with a rating of 50 for a building that has a rating. For buildings without rating, the straight national average is displayed. For any building with a Data Center (no matter what combination of space types is present), the National Average Source EUI should display as follows:

- If the building has a rating – The National Average Source EUI shall be the Source EUI associated with a rating of 50 (kBtu/ft^2)
- If the building does not have a rating
    - If the Data Center is more than 50% (i.e. classified as Data Center) – The National Average Source EUI should be N/A
    - If the building is classified as anything other than Data Center – The National Average Source EUI should pull the CBECS average value for the majority space type.

In addition, a new view, ***Performance: Data Centers*** should be established as a standard view available within Portfolio Manager. It shall include the following elements:

- Facility Name
- Current Rating
- Current Energy Period End Date
- Current Data Center PUE
- Current Source IT Energy (kBtu)
- Current Total Source Energy (kBtu)
- Current Source Energy Intensity (kBtu/sq. ft.)

III. Model Formats and Coefficients

The coefficients for the new Data Center model are presented in **Table 3**. This model is unique with respect to all other benchmark models. The dependent unit of analysis is ***Power Usage Effectiveness***, or PUE. The model will compute a predicted value for PUE. The actual value for PUE will be divided by this prediction to yield an energy efficiency ratio. The lookup table is based on these energy efficiency ratios, similar to other space models (Office, K-12 School, Retail, etc). The lookup table is presented in **Attachment 6**. Section IV details the specific procedures for computing the energy performance rating using the modeling equation.

Table 3 Summary of Coefficients and Centering Terms for the new Data Center Benchmark Model			
Variable Name	**Variable Definition**	**Variable Coefficient**	**Reference Centering Value**
Constant	Regression Intercept	1.924	NA
Annual IT Energy	Annual IT Energy in Source TBtu (*TeraBtu, Source Energy)* *(1 TeraBtu = 1 trillion Btu)*	-0.9506	0.2091

Note:

- *There is only one independent variable, Annual IT Energy*
- *Annual IT Energy is computed in Source Energy, and entered in Tera Btu (TBtu):*
  Annual IT Energy kWh(3.412kBtu/kWh)*(3.34 Source/Site Electric)*(1 TBtu/10^9kBtu)*
- *The Annual IT Energy adjustment is capped at 0.4 TBtu*
- *HDD and CDD are not part of this model – Internal loads in a Data Center can be ten times the ambient heating and cooling loads through the building envelope. As such, HDD and CDD are not statistically significant at Data Centers.*

The variables and coefficients presented in **Table 3** are combined to compute the Source EUI according to the following equation:

Predicted PUE = 1.924 + (-0.9506) * (Annual IT Energy – 0.2091)

There is a cap applied to the Annual IT Energy, of 0.4 TBtu. That is, in the regression equation the maximum value that can be entered for Annual IT Energy is 0.4 TBtu. For a given building, the regression should compare the actual Annual IT Energy with 0.4 TBtu. The lesser of the two values should be used to compute the regression equation. This is summarized in **Table 4**.

Table 4 Summary of IT Energy Adjust Cap Requirements	
Actual Annual IT Energy Value (TBtu)	**Regression Equation**
0.2	Predicted PUE = 1.924 + (-0.9506) * (***0.2*** – 0.2091)
0.4	Predicted PUE = 1.924 + (-0.9506) * (***0.4*** – 0.2091)
0.6	Predicted PUE = 1.924 + (-0.9506) * (***0.4*** – 0.2091)

In particular, some items to note with respect to the calculation:

- The Predicted PUE is the predicted value for Total Source Energy / Annual Source IT Energy
- The Actual PUE value is the Total Source Energy /Annual Source IT Energy
  - Where both values are computed in kBtu
  - Any time a calculation of PUE is computed, Source Energy and Source IT Energy must be in ***the same units*** so that this metric is always a ***dimensionless ratio***.
- The Annual IT Energy in the regression equation is expressed in units of TeraBtu (TBtu):

$$\textbf{1 TBtu} = \mathbf{10^{12}}\ \textbf{Btu}$$
$$\textbf{1 TBtu} = \mathbf{10^{9}}\ \textbf{kBtu}$$

IT Energy kWh*(3.412 kBtu/kWh)*(3.34 Source/Site)*(1 TBtu/10^9kBtu)
= IT Energy Source TBtu

The lookup table is presented in **Attachment 6**. This table lists energy efficiency ratios (computed as Actual PUE/Predicted PUE). This table should be read as follows:

- If the ratio is less than 0.6569, the Data Center should receive a 100
- If the ratio is greater than or equal to 0.6569 but less than 0.6879, the Data Center should receive a 99.
- If the ratio is greater than or equal to 0.6879 but less than 0.7082, the Data Center should receive a 98.
- If the ratio is greater than or equal to 1.2831 but less than 1.3315, the Data Center should receive a 2.
- If the ratio is greater than or equal to 1.3315, the Data Center should receive a 1.

IV. Procedures to Compute Energy Performance Ratings

This section details the procedures that should be used to compute energy performance ratings for all buildings with Data Centers. These procedures are broadly similar to other models, but are unique, because they use the Power Usage Effectiveness, or PUE value.

<u>Procedure to rate a building that consists of one Data Center space (Base Case)</u>

1. Calculate the predicted PUE for the building using the equation presented in Section II.
    a. IT Energy for this value should be input in ***source TBtu***.
    b. IT Energy will be based on whichever element is required for the specific Data Center, either the UPS or PDU meter.
    c. There can be multiple UPS or PDU meters. If there is more than one meter of the ***required*** type, the energy use from those meters should be added together.
    d. 12 months of IT Energy is required for the equation. 11 months of data can be extrapolated to 12 months, if necessary.
    e. Remember that the adjustment for Annual IT Energy in TBtu is capped at 0.4, as summarized in Table 4.
2. Calculate the actual PUE for the building
    a. Actual PUE is computed as:
        i. Total Building Source kBtu/Annual Source IT Energy kBtu
    b. The IT Energy in the calculation for the actual PUE is in ***kBtu***
    c. There is a requirement for 12 months of Total Energy and IT energy for this calculation. 11 months of data may be extrapolated to 12 months.
    d. Source energy conversions shall follow the factors introduced on 10/1/2007, which can be found at: http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf
    e. Buildings with fewer than 11 months of data for ***either IT Energy or total source energy*** should receive NA for the rating.
    f. Buildings with 12 months of data for total source energy and IT Energy that do not overlap should receive NA for the rating.

3. Compute the energy efficiency ratio
    a. Efficiency ratio = Actual PUE/Predicted PUE
4. Lookup the energy efficiency ratio in the lookup table.

Procedure to rate a building that consists of multiple Data Center spaces

1. Combine all Data Center Spaces into a single space. Attributes should be combined as follows:
    a. Gross floor area: the square foot should be added across all Data Center spaces.
    b. IT Energy: The Annual IT Energy should be added across all Data Center spaces.
        i. When multiple data center spaces are present, they may not have the same IT Energy Configuration. As such, one space may be required to supply PDU data, while another will be required to supply UPS data. Each data center space should have a stored field for the IT Energy data, based on its required elements.
        ii. Annual IT Energy (12-month value) should be computed for each space.
        iii. Annual IT Energy (12-month value) should be summed across all Data Center Spaces.
2. Compute the predicted PUE according to the equation presented in Section III
    a. Use the total combined Gross Floor Area and IT Energy from the preceding step.
    b. Apply the same conditions as described in the Base Case, Step 1.
3. Calculate the actual PUE for the building, with all the conditions described in the Base Case, Step 2.
    a. Actual PUE is computed as:
        i. Total Building Source kBtu/Annual Source IT Energy kBtu
    b. The IT Energy in the calculation for the actual PUE is in ***Source kBtu***
        i. This should be the IT Energy across all Data Center spaces, as computed above.
4. Compute the energy efficiency ratio
    a. Efficiency ratio = Actual PUE/Predicted PUE
5. Lookup the energy efficiency ratio in the lookup table.

Procedure to rate a building that consists of one Data Center space and another primary space

1. Calculate the predicted PUE for the Data Center using the equation presented in Section III, with all conditions described in the Base Case, Step 1.
2. Calculate the predicted Source Energy for the data center
    a. Predicted source energy (kBtu) = predicted PUE * Annual Source ITEnergy (kBtu)
    b. Note that the PUE is multiplied by the Source IT Energy ***in kBtu (not TBtu)***
3. Calculate the predicted Source Energy for the other primary space
    a. For a Retail, Office, Bank/Financial, Courthouse, Supermarket, Hotel, Warehouse, K-12, or Worship space, this will require computing a predicted Source EUI and the using the time weighted floorspace to translate the predicted EUI into a predicted source energy.

b. For a Medical Office, ***Hospital*** or Dormitory, this will require computing a predicted LN(Source Energy) and then using the exponential function, *e*, to convert the prediction into units of Source Energy.
    i. ***Note that a Data Center can still be combined with a Hospital Space. Because the terminology "primary" and "secondary" was removed from the website, this allowance will not break any published rules***

4. Calculate the predicted source energy for the entire building
    a. This is equal to the sum of the predicted source energy for the Data Center (Step 2) and the predicted source energy for the other primary space type (Step 3).
5. Create a combined lookup table for the building. As with other new models (post 10/2007), there are actually two options for this process. They are both presented below and they are mathematically equivalent. SRA should determine the method that allows for the most streamlined computation within Portfolio Manager and Target Finder. ***Can SRA please clarify whether they migrated to Option B in the August 2009 release? This was under consideration.***
    a. *Option A = Add Across in Units of Source Energy*
        i. For each space with an LN(Source Energy) model format (Dormitory, Hospital, Medical Office) a lookup table already is created in units of Source kBtu
        ii. For each model with a Source EUI model format (e.g. office, retail), there is a lookup table of energy efficiency ratios. This table can be converted into units of source energy by multiplying each ratio by the predicted EUI and by the time weighted floor area to get a source kBtu value.
        iii. For the Data Center Model, the PUE values can be converted into units of source energy by multiplying each PUE ratio by the predicted PUE and by the IT Energy (in Kbtu) to get a source kBtu value
        iv. Add the resulting source energy values across at each rating.
        v. **Table 5** summarizes this calculation at three points on the lookup table for a combined Office and Data Center.

Table 5
Example Rating for a Combined Lookup Table in Source Energy (kBtu)

Rating	**Data Center Space**		**Office Space**		**Combined Source Energy**
	Ratio	**Source Energy (kBtu)**	**Ratio**	**Source Energy (kBtu)**	
95	0.7474	298,960,000	0.435548	4,355,480	303,315,480
75	0.8648	345,920,000	0.691894	6,918,940	352,838,940
40	0.9957	398,280,000	1.041511	10,415,110	408,695,110

Note:
- *The data center is assumed to have **a predicted PUE of 2.0** and a **Source IT Energy of 200,000,000 kBtu (0.2TBtu)***
- *The office is assumed to have a **predicted EUI of 200 kBtu/ft^2** and a **floor area of 50,000 ft^2***

b. *Option B – Combined Lookup Table of Efficiency Ratios (only for Data Center with Spaces that have EUI models, listed above under Step 3a)*
    i. For space types that have an EUI model format, Option A and B are identical.

ii. Option B creates a table in energy efficiency ratios that is ***weighted by the percent of the predicted source energy for each space type***.

iii. For the example in **Table 5**:

1. Data Center Predicted Source: (2.0)*(200,000,000kBtu) = 400,000,000 kBtu
2. Office Predicted Source: (200kBtu/ft^2)*50,000ft^2 = 10,000,000 kBtu
3. Total Predicted Source: 400,000,000 + 10,000,000 = 410,000,000

iv. For the example in **Table 5**

1. Percent of predicted source for Data Center: 400,000,000/410,000,000 = 97.56%
2. Percent of predicted source for Office: 10,000,000/410,000,000 = 2.44%

v. **Table 6** demonstrates how the efficiency ratios for each space should be combined using the percent of predicted source energy to weight the values.

Table 6
Example Rating for a Combined Lookup Table in Source Energy (kBtu)

Rating	Data Center Space		Office Space		Combined Energy Efficiency Ratio
	Ratio	Percent Predicted Source	Ratio	Percent Predicted Source (kBtu)	
95	0.7474	97.56%	0.435548	2.44%	0.739791
75	0.8648	97.56%	0.691894	2.44%	0.860581
40	0.9957	97.56%	1.041511	2.44%	0.996818

Note:

- *The data center is assumed to have **a predicted PUE of 2.0** and a **Source IT Energy of 200,000,000 kBtu (0.2TBtu)***
- *The office is assumed to have a **predicted EUI of 200 kBtu/ft^2** and a **floor area of 50,000 ft^2***

6. Compute the Actual Source Energy (kBtu) for the building
   a. This total should be equal to 12 months worth of energy data.
   b. This actual value should ***not*** be weather normalized.
   c. Source energy conversions shall follow the factors introduced on 10/1/2007, which can be found at: http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf
   d. Buildings with more than 11 months of data but less than 12 months should use an extrapolated value for the 12 month period. Buildings with fewer than 11 months of data should receive N/A.
7. Lookup the Actual Source Energy (kBtu) in the combined lookup table created in Step 5
   a. For ***Option A***: The actual Source Energy (from step 6) for the building can be looked up directly in the table.
   b. For ***Option B***:
      i. Compute the energy efficiency ratio for the building. The is the Actual Source Energy (Step 6) divided by the Predicted Source Energy (Step 4)
      ii. Lookup the energy efficiency ratio in the combined lookup table.

Procedure to rate a building that consists of one Data Center space and a secondary space

The methodology for incorporating a secondary space (i.e. Swimming Pool and Parking Garage) with a Data Center should follow the standard procedures instituted on October 1, 2007. Note that the swimming pool calculations were modified in February 2009. If there is a swimming pool combined with a Data Center, the new 2009 calculations should be applied.

Both Parking Garage and Pool have equations that result in a predicted source energy use (or energy use per square foot). This prediction should be ***subtracted*** from the actual source energy consumption of the building (Data Center) prior to computing the PUE and the efficiency ratio. In the case where Data Center is combined with another space type and actual energy values (rather than PUE and ratio) are used to lookup the rating, then the secondary prediction should be subtracted from this actual value.

Per discussions prior to the October 1, 2007 release date, this methodology, on rare occasions can yield a negative value for the actual source energy consumption. This is not expected to be common. However, it is possible, especially in a theoretical net zero building, or a building that is not connected to the grid. If a negative value is obtained for the actual source energy, the building should be assigned an actual source energy value of zero, and therefore the building should receive ***an energy performance rating of 100***. SRA should maintain a list of these buildings and their operating characteristics, and present this list to EPA on a quarterly basis. This list should include building ID, in addition to energy information and operating characteristics.

Procedure to rate a building using defaults for Data Center

Please refer to Section I. Ultimately, defaults ***will not be permitted***. However, for a temporary period (4/15/2010 – 4/15/2012), default values will be allowed for facilities where the ***data center is 10% or less of the total*** floor area. In these cases, the default will be applied to estimate source energy relative to an EUI of 2,000 Source kBtu/ft^2. Using this default, the data center will be treated as a secondary space. Refer to Section I, and the preceding discussion on secondary spaces for greater detail.

Procedure to rate a building that consists of Data Center and an Other space

This procedure is unchanged relative to the standard protocol in Portfolio Manager. Generally, the standard protocol adjusts the look-up table upward by the percent of the floor area that is occupied by Other. Implicitly this assumes that the Other space will have about the same EUI as the rated space. Other cannot be used for more than 10% of a building.

Note that multifamily housing is incorporated into a rating according to a similar procedure as the Other space category. Multifamily housing, like other, is limited to 10% of the total floor area. The procedures for combining Multifamily with Data Center will be the same as the procedures for combining Multifamily with any other ratable space type.

Negative PUE Predictions

While some models have the possibility of achieving a negative predicted EUI value, there is no possible way to receive a negative PUE prediction. The only independent variable (IT Energy in TBtu) is capped at a value that does not result in negative predictions. As such, there will be no problem with negative EUI predictions for the Data Center Model.

V. Eligibility Requirements

As with other benchmarking models, there are two sets of eligibility requirements for the new Data Center rating model: requirements to receive a rating; and checks associated with label applications. ***Note that eligibility criteria are always applied once per space type***. All Data Center spaces in a single building should be combined together (see procedures for combining Data Center Spaces in the preceding section). Then, the eligibility rules are applied to the resulting combined space.

Eligibility to receive an energy performance rating

The following conditions must be met in order for a Data Center (or building with a Data Center) to earn an energy performance rating

1. There must be 12 months of IT Energy Data
    a. This condition should be applied to ***all*** meters of the ***required type*** (could by UPS or PDU).
    b. For a building with multiple data center spaces, one space could require the UPS while another requires the PDU. There must be 12 months of data for all required meters.
    c. If a building has a revision history, the required field may have changed from UPS to PDU (or vice versa). In this case, the revision history should designate which meters are required for each time period (pre- and post- revision). There are 12 total months of energy required, but this could be 7 months of UPS and 5 months of PDU.
    d. For a building that uses "update" to change the IT Energy configuration from "Apply Default" to any other selection, ***the default should be applied until such time as they have 12 months of energy data***.
        i. For example if the default is selected for 1/1/2000 – 4/1/2010, and the IT configuration is updated taking effect on 4/1/2010, then the default should still be applied until there are 12 months of IT Energy (until 3/31/2011). During that time they should see a meter alert, and the rating should have the ** to designate that defaults are used.
2. ***If the Data Center is using defaults (only allowed until April 2012)***
    a. The data center cannot exceed 10% of the total gross floor area
        i. Data Center <=10% of the floor area

Any building with a Data center that fails to meet one of these requirements should receive N/A for the Rating. SRA should incorporate these requirements with the eligibility criteria on the website (http://www.energystar.gov/index.cfm?c=eligibility.bus_portfoliomanager_eligibility).

Updating the website will also include incorporating these criteria into the posted PDF table of eligibility. ***It has previously been determined that SRA will be responsible for maintaining the current version of the eligibility PDF and for updating it with new releases, as needed.***

Please note that there is ***no size limit*** associated with the data center floor area in order to compute a rating.

<u>Label eligibility flags</u>

The following conditions should be flags for the purposes of applying for the label. If a label application has values that fall outside of these ranges, the applicant should be prompted for a response.

There are three checks that should apply to any building classified as a Data Center. This could include a building with only Data Center space, or a building with multiple space types of which Data Center constitutes the majority (over 50%).

1. The EUI should not be
    - Less than 850 kBtu/ft^2
    - Greater than 6500 kBtu/ft^2
2. The Annual IT Energy should not be:
    - Less than 0.040 TBtu
    - Greater than 0.50 TBtu
    - In the question to the user, the UPS value should be presented ***in units of kBtu and in units of kWh*** *(to help them check).*
3. Until April 2012 data centers ***are permitted to use Default IT Energy, if the Data Center is less than 10% of the total floor area.***

In addition, there are two checks that should be applied for buildings classified as Data Center which contain ***only Data Center space***:

1. The gross floor area should not be:
    - Less than 5,000 ft^2
    - Greater than 400,000 ft^2
2. The PUE value should not be:
    - Less than 1.3
    - Greater than 3.0

VI. Consistency Requirements

This document has been structured to detail the calculation requirements for benchmarking with the new Data Center model in Portfolio Manager. It does not cover an exhaustive list of all the places where the changes will apply. SRA will be expected to update the following areas of the tool and the web accordingly.

1. Portfolio Manager and Target Finder
2. Portfolio Manager/Target Finder Help Screens

3. Automated benchmarking services
4. Business Intelligence Tool and Data Warehouse
5. Energystar.gov web content
    a. Space definition and list of attributes
    b. Eligibility criteria website
    c. Eligibility criteria PDF file
    d. New Data Center Technical Description (new document to be provided by EPA)
6. Data Checklist (prints with SEP)

If SRA identifies areas of the tool that will require additional content and language, EPA will work with SRA to ensure that appropriate content is developed. EPA expects that SRA will search PM and the Web to identify places that may be impacted by these changes.

VII. Model Testing, Score Change Report, and Training

Score Change Report

EPA will require a score change report (in Excel) in order to test the new model, verify SRA scripts, and prepare the commercial outreach team for the new rating release. This score change report should be similar to the report created for the August 2009 Religious Worship Model. This means that all buildings in Portfolio Manager that contain a Data Center space should be included in the report.

Note that separate score change reports are being requested for Office and Retail spaces, based on planned changes for those spaces. Buildings that have Data Center in combination with Office and Retail should appear in both reports, reflecting all changes.

It is EPA's intention that the information contained in this report will provide all required fields so that the ratings can be completely replicated. If SRA has any questions or identifies any missing elements, it would be useful if they could alert EPA prior to generating the report. This way, the report should be complete the first time it is created.

The sample should be drawn to include all buildings that:

1. Have at least one Data Center space
    a. ***Unlike in other change reports, it is not required that the building currently have a rating. Some buildings with Data Center over 10% of the floor area will not have ratings. These buildings will also not have ratings in the report, because they are not eligible to use defaults. However, it will be useful for EPA to know how many of these facilities exist, and other basic characteristics.***
2. Are not labeled "Test" or "Sample"
3. Are not owned by EPA or its contractors

In addition, please note the following:

1. The Office and Retail models will also have small changes on April 15, 2010. Hence, the ***new ratings in the score change report should reflect both the Retail and Office changes***. A building with a Data Center, Office, and Retail space should have its new rating computed with the new rules for all three spaces types.

a. EPA has requested a separate report to analyze each change. The example building would appear in all three excel reports.

2. The list of desired column headings is presented in **Attachment 7**. This list is similar to the list requested for August 2009 testing. However, the Data Center characteristics have been added.
3. All numbers should be displayed/stored as numbers (not as text/strings)
4. All yes/no variables (for example Presence of Cooking) should be displayed as either 1 or 0 (for Yes or No). Please do not display these as coefficient values.
5. All attribute values (including square foot) should be presented as the time-weighted attribute values that are used to predict the Source EUI for the building.
6. The attribute values for non-Data Center spaces (e.g. Office, Retail) should only be included if the sample contains a building with that space. (e.g. if there are no buildings in the sample that contain supermarkets, then there is no need for any supermarket attribute columns).
7. Percent Heated should be reported as a fraction between 0 and 1 (i.e. the values that are used in the equations).
8. The "count of primary spaces" should reflect the total number of spaces, ***not*** the total number of space types. For example, a building with 5 Data Center spaces has 5 primary spaces (not 1).

<u>Model Testing</u>

In addition to this typical score change report, EPA is providing SRA with sample facility data in an Excel file. An additional Excel Score Change file will be required, to present the computed scores for these test facilities. This will be necessary to ensure that scripts are running properly, especially because all building in Portfolio Manager will be assigned defaults, which have inherently different calculations.

The test facilities have been provided in an Excel File titled: DataCenter_SampleData_20091204_forSRA. This file is loosely modeled on the import templates. It contains three tabs, one for the building attribute information, one for the energy data, and another for the IT Energy data. Please note the following:

- There are a total of 50 sample facilities
- There are monthly energy values provided for energy consumption and for IT consumption.
- The IT configuration is listed, so some buildings have UPS, others have PDU, and some have both UPS and PDU (so, the correct required element must be applied).
- A sample of the buildings contain a combination of Data Center and Office space, to ensure that the combined rating is computed correctly.

SRA will be expected to ***upload the test data for all 50 test buildings*** onto the Staging Server, under Alexandra Sullivan's account (asullivan).

SRA will also be expected to provide a summary Excel file of the ratings for all 50 test buildings. This file should ***follow a format similar to the general score change report***. It should contain all of the same columns in the typical score change report, but note that only

Office and Data Center spaces are present, so there will not need to be columns for attributes of any other space types.

Training

This model will require special training prior to its release, to prepare two separate audiences: commercial real estate partners who currently use Portfolio Manager, but do not know technical details of data centers; and data center stakeholders who helped with model development, are experts on data centers, but are Portfolio Manager novices. The Technical and Commercial Real Estate teams at EPA will be coordinating to plan this outreach and training.

To support this training EPA is going to need SRA's assistance in preparing screenshots or wireframes of what the Portfolio Manager screens will look like for Data Center. This should include screen shots for the Add and Edit space pages, as well as a screen shot for the new Data Center View.

EPA and SRA need to discuss the development of screen shots and develop a timeline. EPA cannot wait until the typical staging review (two weeks prior to release) to have this information. Planned outreach will need to begin as early as possible. It is acceptable for the wire frames to be drawn up based on requirements, with the understanding that some tweaks may occur prior to final release. However, some tangible screen shots or mock ups will be necessary to support the outreach.

VIII. Attachments

Attachment A.1 – Proposed Requirements for the Add Space Field

Proposed Screen Elements:

Required for Benchmarking				
Space Attribute	Space Attribute Value	Use Default Value	Units	Effective Date (When attribute value was first true)
Gross Floor Area	--User entry--	N/A	Drop Down: SqFt, SqM	Date – populate with space effective date

Required for Benchmarking	
IT Energy Configuration	Effective Date (When attribute value was first true)
Select the IT Energy Configuration present at this facility: Uninterruptible Power Supply (UPS) supports only IT equipment.	Date – populate with space effective date
IT Energy (kWh) must be entered as follows to obtain a Rating: **IT Energy from the UPS Meter is required.** **IT Energy from the PDU Meter is optional.**	

IT Energy Meters Add Meter				
Meter Name	Meter Type	Energy Type	Last Meter Entry (End Date)	Alerts
No Meter Defined				

Notes:

- Dropdown menu options are presented in Table A.1, along with the associated text to display for user-entry requirements.

Table A.1
Summary of Optional and Required Elements based on IT Energy Configuration

Option	IT Energy Configuration	Text to Display
1	Uninterruptible Power Supply (UPS) Meter supports only IT Equipment. ***(Preferred)***	IT Energy from the output of the UPS Meter is required. IT Energy from the input to the PDU Meter is optional.
2	UPS Meter includes non-IT load of 10% or less	IT Energy from the output of the UPS Meter is required. IT Energy from the input to the PDU Meter is optional.
3	UPS Meter includes non-IT load greater than 10%. Non-IT load is sub-metered.	IT Energy from the output of the UPS Meter is required, with all Non-IT load subtracted from the total. IT Energy from the input to the PDU Meter is optional.
4	UPS Meter includes non-IT load greater than 10%. Non-IT load is **not** sub-metered.	IT Energy from the input to the PDU Meter is required. IT Energy from the output of the UPS Meter (which includes non-IT load) is optional.
5	Facility has no UPS Meter.	IT Energy from the input to the PDU Meter is required.
6	IT Energy is not currently metered at this facility – Apply defaults. (View eligibility requirements.)	IT Energy is not necessary at this time, but will be required in the future. Metering equipment should be installed.

Attachment A.2 – Proposed Requirements for Select Type and Number of IT Energy Readings

Proposed screen elements:

* **Required**

*Enter Meter Name	Free Response Field (string)
*Select Meter Type	Dropdown Menu

Select Number of Meter Entries to be added and Start Date for first entry:			
Meter Entries to Add	*Start Date (MM/DD/YYYY)	Energy Type	Units
Dropdown: range from 1 to 12	--User entry--	Electricity	kWh

Cancel Continue

Notes

- User is required to name the meter
- The Meter Type dropdown should allow for two options:
  - UPS Output Energy
  - PDU Input Energy
- Users must enter electricity in kWh. There are no other energy types or units.
- The continue button will take the user to a screen to enter the meter entries. Cancel will go back to the Add Space page.
- The dropdown menu only needs to go up to 12. It does not need to go to 48 like the meter entry screen.

Attachment A.3 – Proposed Requirements for the Add IT Energy Use Screen

Depending on the type of energy meter selected, a UPS or PDU meter table will appear, with the correct number of rows for entry. Unlike Energy Meters, there is no need for a cost column.

Sample for UPS entry:

Uninterruptible Power Supply (UPS) Output Energy Use		
Start Date	End Date	Energy Use (kWh)

Cancel Continue

Sample for PDU entry:

Power Distribution Unit (PDU) Input Energy Use		
Start Date	End Date	Energy Use (kWh)

Cancel Continue

Notes:

- Default will be even monthly entries, based on the start date, as for energy meters. Start and end dates should be editable, in case the user has different measured periods.
- Users must enter electricity in kWh. There are no other energy types or units.
- The continue button will take the user to a screen to enter the meter entries. Cancel will cancel the addition of the meter, and return the user to the Add Space page.

Attachment A.4 – Proposed Requirements for Edit Space Fields

Proposed Screen Elements:

Current Space Attribute Values What is this?						
Space Attribute	Space Attribute Value	Use Default Value	Units	Effective Date (When attribute value was first true)	Last Updated	
Gross Floor Area	Floor Area	N/A	Unit (Sq. Ft. or Sq. M.)	Date	Date/user	Edit (link)
IT Energy Configuration	Type of IT Energy (that was selected from dropdown list)	N/A	N/A	Date	Date/user	Edit (link)

IT Energy Meters Add Meter What is this?				
Meter Name	Meter Type	Last Meter Entry (End Date)	Alerts	
Meter 1	UPS Output Energy	Date	Data > 120 days old.	Delete Meter
Meter 2	PDU Input Energy	Date		Delete Meter

Notes

- The “what is this?” link will go to the list of space use information for Data Center in PM Help. Since IT EnergyIT Energy is considered an attribute, the two “what is this?” links will go to the same Help page.
- Use Default Value will display N/A or “yes”, as appropriate.
- Only the energy meters entered by the user (UPS, PDU, or both) will be shown. Meters can be selected for editing by clicking the Meter Name, as they are for Energy Meters.
- Edit for IT Energy Meters
  - This should proceed like Edit for a typical energy meter, you should see all your meter readings, and be able to select “add meter entries”
- Edit for IT Configuration and Gross Floor Area
  - This should proceed like Edit for all standard space attributes, including an option to use the correct or update feature.

Attachment A.5 – Proposed Requirements for Target Finder

2. Facility Characteristics		
* Select Space Type(s) for this project		
Dropdown Menu of space types		
Data Center		**Delete**
***Gross Floor Area**	***Annual IT Energy Consumption**	
Entry field – Sq. Ft.	Entry Field – in kWh	

Attachment A.6 – Data Center Model Lookup Table

Table A.6 Data Center Lookup Table								
Rating	**Cumulative Percent**	**Ratio >=**	**Ratio <**		**Rating**	**Cumulative Percent**	**Ratio >=**	**Ratio <**
100	0%	0.0000	0.6569		50	50%	0.9548	0.9584
99	1%	0.6569	0.6879		49	51%	0.9584	0.9620
98	2%	0.6879	0.7082		48	52%	0.9620	0.9657
97	3%	0.7082	0.7236		47	53%	0.9657	0.9694
96	4%	0.7236	0.7364		46	54%	0.9694	0.9731
95	5%	0.7364	0.7474		45	55%	0.9731	0.9768
94	6%	0.7474	0.7571		44	56%	0.9768	0.9805
93	7%	0.7571	0.7659		43	57%	0.9805	0.9843
92	8%	0.7659	0.7739		42	58%	0.9843	0.9880
91	9%	0.7739	0.7814		41	59%	0.9880	0.9919
90	10%	0.7814	0.7883		40	60%	0.9919	0.9957
89	11%	0.7883	0.7949		39	61%	0.9957	0.9996
88	12%	0.7949	0.8011		38	62%	0.9996	1.0035
87	13%	0.8011	0.8071		37	63%	1.0035	1.0075
86	14%	0.8071	0.8127		36	64%	1.0075	1.0115
85	15%	0.8127	0.8182		35	65%	1.0115	1.0156
84	16%	0.8182	0.8235		34	66%	1.0156	1.0198
83	17%	0.8235	0.8285		33	67%	1.0198	1.0240
82	18%	0.8285	0.8335		32	68%	1.0240	1.0282
81	19%	0.8335	0.8383		31	69%	1.0282	1.0326
80	20%	0.8383	0.8429		30	70%	1.0326	1.0370
79	21%	0.8429	0.8475		29	71%	1.0370	1.0415
78	22%	0.8475	0.8520		28	72%	1.0415	1.0461
77	23%	0.8520	0.8563		27	73%	1.0461	1.0508
76	24%	0.8563	0.8606		26	74%	1.0508	1.0556
75	25%	0.8606	0.8648		25	75%	1.0556	1.0605
74	26%	0.8648	0.8689		24	76%	1.0605	1.0656
73	27%	0.8689	0.8730		23	77%	1.0656	1.0708
72	28%	0.8730	0.8770		22	78%	1.0708	1.0761
71	29%	0.8770	0.8810		21	79%	1.0761	1.0816
70	30%	0.8810	0.8849		20	80%	1.0816	1.0873
69	31%	0.8849	0.8888		19	81%	1.0873	1.0932
68	32%	0.8888	0.8926		18	82%	1.0932	1.0994
67	33%	0.8926	0.8964		17	83%	1.0994	1.1058
66	34%	0.8964	0.9002		16	84%	1.1058	1.1125
65	35%	0.9002	0.9039		15	85%	1.1125	1.1195
64	36%	0.9039	0.9076		14	86%	1.1195	1.1269
63	37%	0.9076	0.9113		13	87%	1.1269	1.1348
62	38%	0.9113	0.9150		12	88%	1.1348	1.1432
61	39%	0.9150	0.9186		11	89%	1.1432	1.1521
60	40%	0.9186	0.9223		10	90%	1.1521	1.1619
59	41%	0.9223	0.9259		9	91%	1.1619	1.1725
58	42%	0.9259	0.9295		8	92%	1.1725	1.1842
57	43%	0.9295	0.9331		7	93%	1.1842	1.1974
56	44%	0.9331	0.9367		6	94%	1.1974	1.2126
55	45%	0.9367	0.9403		5	95%	1.2126	1.2306
54	46%	0.9403	0.9439		4	96%	1.2306	1.2530
53	47%	0.9439	0.9475		3	97%	1.2530	1.2831
52	48%	0.9475	0.9512		2	98%	1.2831	1.3315
51	49%	0.9512	0.9548		1	99%	1.3315	>1.3315

Attachment A.7 – Summary of Attributes for Score Change Report

Table A.7 – Summary of Columns for Data Center Score Change Report				
General Information	**Data_Center**	**Parking**	**Hotel**	**Warehouse_UNRFG**
Building ID	Data_Center_Floorspace	Parking_TotalFloorspace	Hotel_Floorspace	Warehouse_UNRFG_Floorspace
Old Rating	Data_Ceneter_AnnualPDU_Energy	Parking_OpenFloorspace	Hotel_RoomNumber	Warehouse_UNRFG_Hours
New Rating	Data_Center_AnnualUPS_Energy	Parking_EnclosedFloorspace	Hotel_Workers	Warehouse_UNRFG_Workers
Delta Rating	Data_Center_AnnualIT_Energy	Parking_NotEnclosedFloorspace	Hotel_Cook	Warehouse_UNRFG_WalkinRfgNum
ZIP Code	Data_Center_Hours	Parking_Hours	Hotel_CommRfgNum	Warehouse_UNRFG_PercentCooled
Total Sq Ft (w/o Parking)	**Office**	**Swimming Pool**	Hotel_PercentCooled	Warehouse_UNRFG_PercentHeated
Total Sq Ft (w/Parking)	Office_Floorspace	SwimmingPool_Size	Hotel_PercentHeated	**Warehouse_RFG**
Building Type	Office_Hours	SwimmingPool_Months	Hotel_Laundry	Warehouse_RFG_Floorspace
Label (Y/N)	Office_Workers	SwimmingPool_IndoorOutdoor	Hotel_AvgOccupancy	Warehouse_RFG_Hours
Most Recent Label Year	Office_PCNum	**Medical_Office**	**Religious Worship**	Warehouse_RFG_Workers
Label Year(s)	Office_PercentCooled	Medical_Office_Floorspace	Worship_Floorspace	Warehouse_RFG_WalkinRfgNum
Total Site Energy (kBtu)	Office_PercentHeated	Medical_Office_Hours	Worship_Seats	**Supermarket**
Total Source Eneryg (kBtu)	**Bank**	Medical_Office_Workers	Worship_Weekdays	Supermarket_Floorspace
Weather Normalized Source Energy (kBtu)	Bank_Floorspace	Medical_Office_PercentCooled	Worship_Hours	Supermarket_Hours
Secondary Space Source Energy (kBtu)	Bank_Hours	Medical_Office_PercentHeated	Worship_PCs	Supermarket_Workers
Predicted Source Energy (kBtu)	Bank_Workers	**Dormitory**	Worship_Cook	Supermarket_Cook
Predicted Swimming Pool Energy	Bank_PCNum	Dormitory_Floorspace	Worship_CommRfg	Supermarket_WalkinRfgNum
CDD_Actual	Bank_PercentCooled	Dormitory_Rooms	Worship_PercentHeated	Supermarket_PercentHeated
HDD_Actual	Bank_PercentHeated	Dormitory_PercentCooled	Worship_PercentCooled	Supermarket_PercentCooled
CDD_30YrAvg	**Court**	Dormitory_PercentHeated	**K12**	Supermarket_OpnClsCaseNum
HDD_30YrAvg	Court_Floorspace	Dormitory_CompLab	K12_Floorspace	Supermarket_PCRegisterNum
YesNo_30yrAvg_Used	Court_Hours	Dormitory_Dining	K12_HighSchool	**Retail**
Number of Secondary spaces	Court_Workers	**Hospital**	K12_PCNum	Retail_Floorspace
Number of Primary spaces	Court_PCNum	Hospital_Floorspace	K12_OpenWE	Retail_Hours
Ownership Information	Court_PercentCooled	Hospital_BedNum	K12_Cook	Retail_Workers
BLDG_OWNER_NAME	Court_PercentHeated	Hospital_MaxFloors	K12_WalkinRfgNum	Retail_PCNum
PM_SURVEY_ORG_NAME	**Other**	Hospital_TertCare	K12_PercentCooled	Retail_CashRegisterNum
BDA_USERID	Other_Floorspace	Hospital_Laboratory	K12_PercentHeated	Retail_WalkinRfgNum
BDA_NAME	Other_Hours	Hospital_Laundry	K12_Months	Retail_OpnClsCaseNum
BDA_EMAIL	Other_PCs	Hospital_BuildNum		Retail_PercentCooled
LABEL_OWNER_ORG_NAME	Other_Workers	Hospital_Owner		Retail_PercentHeated
LABEL_PROPMGR_NAME	Other_OtherType			
Building Name				

ENERGY STAR Rating for Data Centers
Results for Participant 26

Over the past two years, EPA has been developing a new energy performance rating for data centers, which will be released in Portfolio Manager in June 2010. EPA relies on external data sets to develop rating models where feasible, but a sufficiently robust set of energy consumption information was not available for data centers. Instead, EPA conducted a survey to collect data for the development of a data center model. EPA coordinated with major industry associations, including Uptime Institute, Green Grid, 7x24 Exchange, AFCOM and Critical Facilities Roundtable, to inform their members and encourage participation. EPA appreciated the participation of Participant 26 in this data collection effort. The data received was extremely valuable in developing and testing potential rating models. This report presents results for Participant 26, using the final rating model resulting from EPA's analysis.

In late 2007, EPA began working with stakeholders and industry leaders to identify the appropriate operating characteristics and energy data to be collected for data center facilities. Subsequently, a data collection period was held from March 2008 through June 2009. Participants submitted data periodically to ICF International for review, and ICF International masked the data before sending it to EPA to maintain confidentiality. By the summer of 2009, ICF International and EPA had collected complete data sets from 120 data centers representing various sizes, types, and locations.

ICF International and EPA applied filters to the data collected, which reduced the number of observations utilized in the final model. EPA required that data centers provide IT Energy measurements at the output of the uninterruptible power supply (UPS meter). A common measurement location was considered necessary to develop an equitable comparison between facilities, and the UPS meter was determined to be the most common measurement location. Also, EPA required that data centers be stand alone facilities. Data for stand alone data centers was more robust and resulted in higher significance for regression models. Using stand alone facilities was also more consistent with the process used by EPA for other space types. After applying these two filters, a final data set of 61 facilities was used for model development.

While facilities excluded through data filters were not directly used in model development, they were used to test the validity of the rating model, and the applicability of the model to all data center types. EPA has determined that facilities will be allowed to obtain an energy performance rating using data from the input to the PDU meter, if a UPS output meter is not available. Additionally, EPA determined that the rating model can be used to rate data centers enclosed with other buildings. Based on these decisions, ICF International is providing rating reports for all 120 data center facilities shared with EPA during the data collection effort.

The final model generates a 1-100 rating for data centers based on the Power Usage Effectiveness (PUE), with adjustments made to account for the IT Energy load at the facility. (Facilities with higher IT Energy are expected to have lower PUE values, based on economies of scale.) See additional model documentation provided by EPA for more details. A rating of 50 indicates that the building performs better than 50% of all similar buildings, while a rating of 75 indicates that the building performs better than 75% of all similar buildings.

The table below presents results for the data center provided by Participant 26. It includes details on the floor area, energy consumption, IT Energy consumption, and PUE for the facility, as well as the final energy performance rating. Please keep in mind that this rating is applicable for the data provided at the end of the data collection in June 2009 and the data center's energy performance may have changed since then. When the data center rating is released in June 2010, EPA encourages Participant 26 to set up a Portfolio Manager account and begin tracking energy performance ratings on an ongoing basis.

Rating Results for Participant 26

Data Center ID	Building SF	Data Center SF	Total Energy (Source kBtu)	IT Energy (Source kBtu)	PUE	Rating
Redacted	183,000	131,037	821,557,198	485,187,316	1.69	46
Ex. 4	147,600	118,447	504,758,561	353,053,233	1.43	88

ENERGY STAR for Data Centers To Be Launched in Portfolio Manager on June 7, 2010

EPA's energy performance rating system helps energy managers assess how efficiently their buildings use energy, relative to similar buildings nationwide. Organizations can obtain energy performance ratings through Portfolio Manager, an interactive energy management tool that allows users to track energy and water consumption of buildings in a secure online environment. The energy performance of a building is expressed on a 1-to-100 scale — a rating of 50 indicates that the building performs better than 50% of all similar buildings, while a rating of 75 indicates that the building performs better than 75% of all similar buildings.

EPA has developed a 1-to-100 energy performance rating for data centers, which will be released in Portfolio Manager on June 7, 2010. To develop the rating, EPA collected data on energy use and operating characteristics from a large representative sample of existing data centers. The statistical regression analysis employed for all of EPA's energy performance rating models was then applied to the data set, resulting in a rating that is applicable for both stand-alone data centers and data centers located within larger buildings.

Overview of the Data Collection Process

In late 2007, EPA began working with stakeholders and industry leaders to identify the appropriate operating characteristics and energy data to be included in the survey. Data was collected during the period from March 2008 through June 2009. Participants provided at least 11 months of energy consumption data, as well as a number of operating characteristics that would allow EPA to make adjustments to the rating for operating constraints outside of the owner or operator's control. By the summer of 2009, EPA had collected complete data from 120 data centers representing various sizes, types, and locations.

Benchmarking Methodology for Data Centers

In collaboration with industry leaders and associations, EPA selected the Power Usage Effectiveness (PUE) as the metric to evaluate data center energy performance. The PUE is a standard industry metric, which equals the total energy consumption of a data center (for all fuels) divided by the energy consumption used for the IT equipment. The PUE generally ranges from a 1.25 – a more efficient data center – to a 3.0, which indicates a less efficient data center. The PUE is computed in terms of source energy, which is the most equitable way to compare buildings that utilize different fuel types.

EPA used statistical regression analysis to identify the operating characteristics that explain the variation in PUE among data centers. Although numerous variables were considered for the model, only the annual IT energy consumption was found to be statistically significant in explaining the variation in energy use. Therefore, the final regression model yields a 1-to-100 rating based on the actual PUE of a data center compared to the predicted PUE based on a building's annual IT energy.

The regression model was developed using data from stand-alone data centers, but rating results for data centers located within a larger building (e.g. office building) were found to be consistent with the stand-alone results. Consequently, the final rating model is applicable for data centers within larger buildings. A Portfolio Manager user must enter the data center as a separate space within a larger building, and obtain a rating for the entire building.

Earn the ENERGY STAR

Once the rating is released in Portfolio Manager, buildings that achieve a rating of 75 or higher can qualify to earn the ENERGY STAR for demonstrating superior energy performance. A professional engineer (PE) must verify that this information is accurate, and that the building operates in accordance with industry standards and indoor environment criteria. When the label application is approved, EPA will send a bronze ENERGY STAR plaque to display on your building.

For More Information: Visit www.energystar.gov/datacenters or email ENERGYSTARdatacenters@icfi.com

3/22/2010

Review of Data Center Test Data Score Change Report – Version 1

This document summarizes the initial review of the Test Data Score Change report for Data Centers, covering expected changes for the June 2010 model release. The report looks excellent. Ratings were verified within 1 point for all but one of the 50 buildings included in the sample. Where differences occurred, reasons for the discrepancies could be determined in most cases. Based on the results of this review, it is believed that a second report will not be necessary.

SRA Test Report

SRA provided a report summarizing the basic tests performed to validate the data. This report identified a few issues/questions for EPA.

- Item 1 indicated that "Test Data Center 12" may have had a typo in the data that caused it to have 3 meters instead of 2. It is correct that there is a typo in the data.
- Item 2 indicated that "Test Data Center 34" only had 10 months of IT energy data and therefore did not get a rating. This was not intended, but did provide a useful check that a building cannot get a rating unless it has at least 11 months of data.

Rating Replication

In general, excellent replication was achieved for ratings in the score change report. Some minor discrepancies were identified.

- The ratings for 45 buildings (90%) matched exactly. This includes 44 buildings that received ratings, as well as "Test Data Center 34" which was not able to receive a rating due to insufficient IT energy data.
- The rating for 1 building (Test Data Center 12) was off by 7 points. This is the building where a typo was identified in the data. It is not clear how Portfolio Manager handled the total energy calculations for this building. They were unable to be replicated.
- The ratings for 3 buildings (Test Data Center 28, 30, and 39) were off by +/- 1 point because of differences in values for Total Source Energy and IT Energy. The calculations used in the spreadsheet to convert monthly energy readings to annual energy values are slightly different than the process used to generate the score change report. If the annual energy values provided by SRA are used in the ratings calculations, then the resulting ratings match exactly. The values in the score change report can be considered correct, and no further action is required.
    - Note also that the Predicted Source Energy results differed slightly from the score change reports, due to the way the annual IT energy values were calculated. If the values provided by SRA were used in the calculations, than the Predicted Source Energy values matched for all buildings except Test Data Center 34, which had insufficient IT energy data.
- The rating for 1 building (Test Data Center 36) was off by 1 point. It is believed that this is due to minor differences in calculations, combined with the fact that the predicted source energy value for this building is near the cutoff point on the lookup table between two ratings.

New Data Center Energy Performance Rating

Alyssa Quarforth and Alexandra Sullivan

May 19, 2010

Technical Tips

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New Data Center Energy Performance Rating

Alyssa Quarforth and Alexandra Sullivan

May 19, 2010

Agenda

- Development Overview
- Global and US Coordination
- Basic Terms and Definitions
- Portfolio Manager Requirements
- Summary
- Questions

Development Overview

Data Center Initiative
Historical Context

- EPA Report to Congress – August 2007
  - Data centers consume 1.5% of US electricity
  - Data center energy use has doubled in the last 5 years *and* is expected to double in the next 5
  - Data center operating costs starting to exceed capital expenditures due to energy
  - Big opportunity for efficiency in data centers
- National data center energy efficiency program – March 2008
  - EPA - ENERGY STAR
  - DOE - Save Energy Now
  - DOE - FEMP
  - www.energystar.gov/datacenters

Data Center Initiative Objective

- Develop a useful rating for industry
  - Can be available for use as soon as possible
  - Based on items that are commonly measured and tracked
- Build on existing ENERGY STAR methods and platforms
- Apply to all buildings with data centers
  - Free standing data centers
  - Larger buildings that contain data centers
- Assess performance at the building level to explain <u>how</u> a building performs, not <u>why</u> it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)

Data Center Initiative Timeline

- October 2007 – March 2008
  - Consultations with industry stakeholders
- March 2008 – June 2009
  - Data collection, Updates to industry
- June – September 2009
  - Analysis & Preliminary rating development
  - Preliminary results presented to industry *(Recording available)*
- October – November 2009
  - Analysis of industry feedback & Final rating development
  - Additional findings presented to industry *(Recording available)*
- June 2010
  - Data Center model scheduled for release

Global and US Coordination

US Industry Coordination

- Meeting with leading industry groups to discuss metric definitions
  - Goal - Develop an agreed set of guidelines for data center energy efficiency measurements, metrics, and reporting conventions, and promote these within the industry
  - Hosted by EPA and DOE in Washington, DC on January 13, 2010
- Participation limited to those US organizations that define energy efficiency metrics for data centers and those that directly represent users of these metrics
- Participants included:
  - EPA
  - DOE
  - The Green Grid
  - The Uptime Institute
  - ASHRAE
  - Silicon Valley Leadership Group
  - 7x24 Exchange
  - US Green Building Council

US Industry Coordination

- Participating organizations agreed on the following 3 major guiding principles
  1) Power Usage Effectiveness (PUE) using source energy is the preferred energy efficiency metric.
  2) IT energy measurements should, at a minimum, be measured at the output of the UPS. The industry should improve measurement capabilities to ultimately enable taking this measurement directly at the IT load (i.e. servers).
  3) For stand-alone facilities, total energy measurement should include all energy sources at the point of utility handoff. For data centers in larger buildings, total energy should include all cooling, lighting, and support infrastructure, in addition to IT load.
- Agreement released with support from all industries in February 2010
  - Available at: www.energystar.gov/datacenters

Global Coordination

- Global agreement and goals
  - Identify key metrics and agree on definitions and protocols
  - Most important goal is a metric for IT Productivity
  - Interim metrics must be clearly defined and agreed to (PUE, IT energy proxies)
- Global agreement on Guiding Principles for PUE
  - Issued following February Meeting
  - Almost identical to US statement
  - Available at www.energystar.gov/datacenters
- Global task force
  - Working to provide clear consistent guidance for metrics
  - DOE, EPA, and Green Grid members overlap on global and US task forces

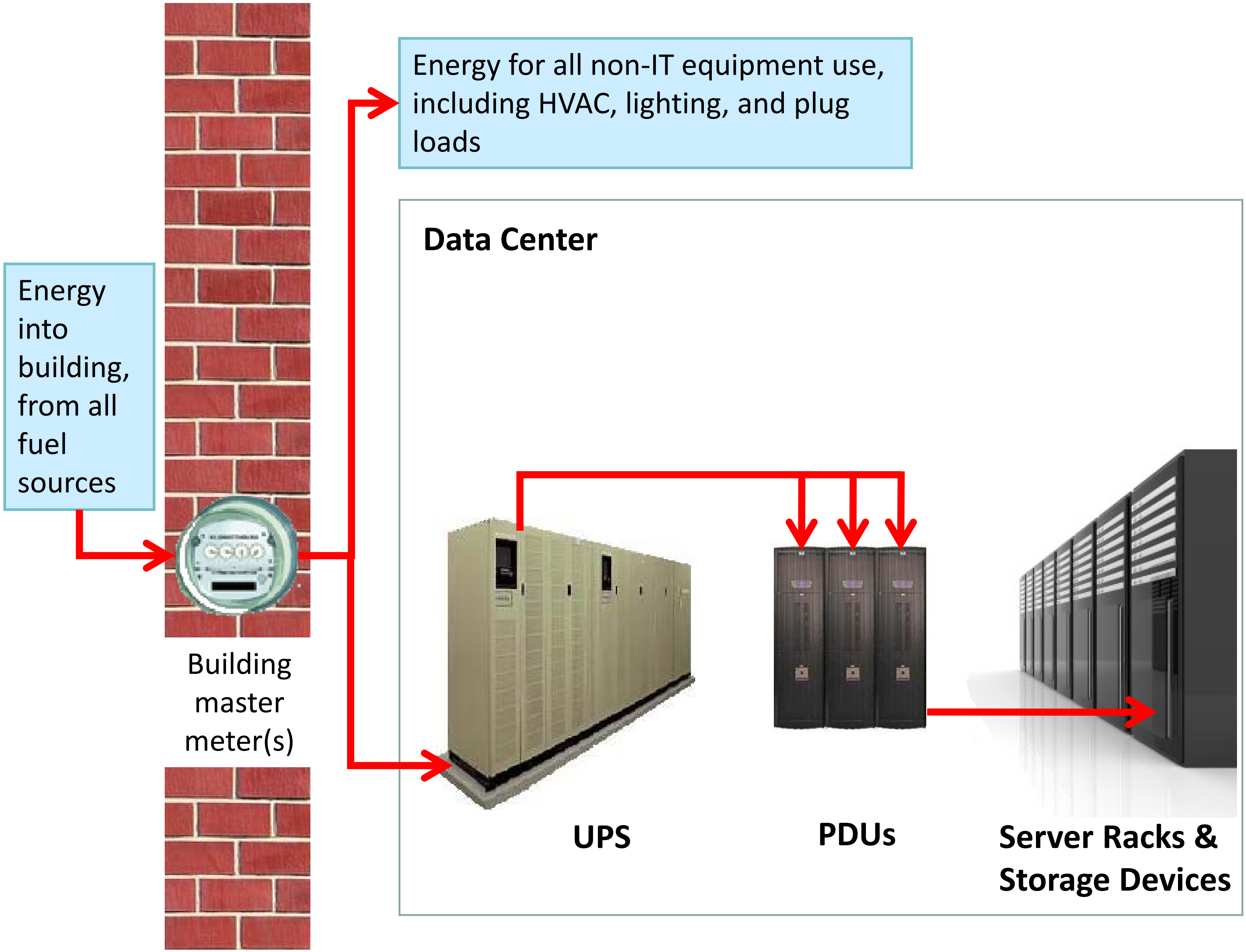
Basic Terms and Definitions

Data Center Definition

- New ENERGY STAR performance scale for Data Center
  - ENERGY STAR score is for spaces specifically designed and equipped for high density computing (server racks, data storage silos, etc)
  - Typically facilities with an Uninterruptible Power Supply (UPS)
  - Usually have dedicated cooling systems
  - May include: traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, hosting facilities
- Applicable for free standing data centers
- Applicable for larger buildings with data centers
- Is **not** for
  - Computer training classrooms
  - Closet with LAN server

Power Usage Effectiveness: PUE

- How is PUE computed?
  - Power Usage Effectiveness = Total Energy/IT Energy
- What does PUE describe?
  - Measure of infrastructure efficiency
  - Captures how much cooling and support energy is required for the IT equipment
  - Does not capture IT equipment efficiency
- Why use PUE?
  - Best available whole building measure at this time
  - Conforms with US and Global guiding principles
- How is an ENERGY STAR score computed?
  - Express ratio (Total Energy/IT Energy) on the EPA ENERGY STAR energy performance scale
  - Each point on scale equals 1 percentile of performance


Energy for all non-IT equipment use, including HVAC, lighting, and plug loads
Data Center
Energy into building, from all fuel sources
Building master meter(s)
UPS
PDUs
Server Racks & Storage Devices

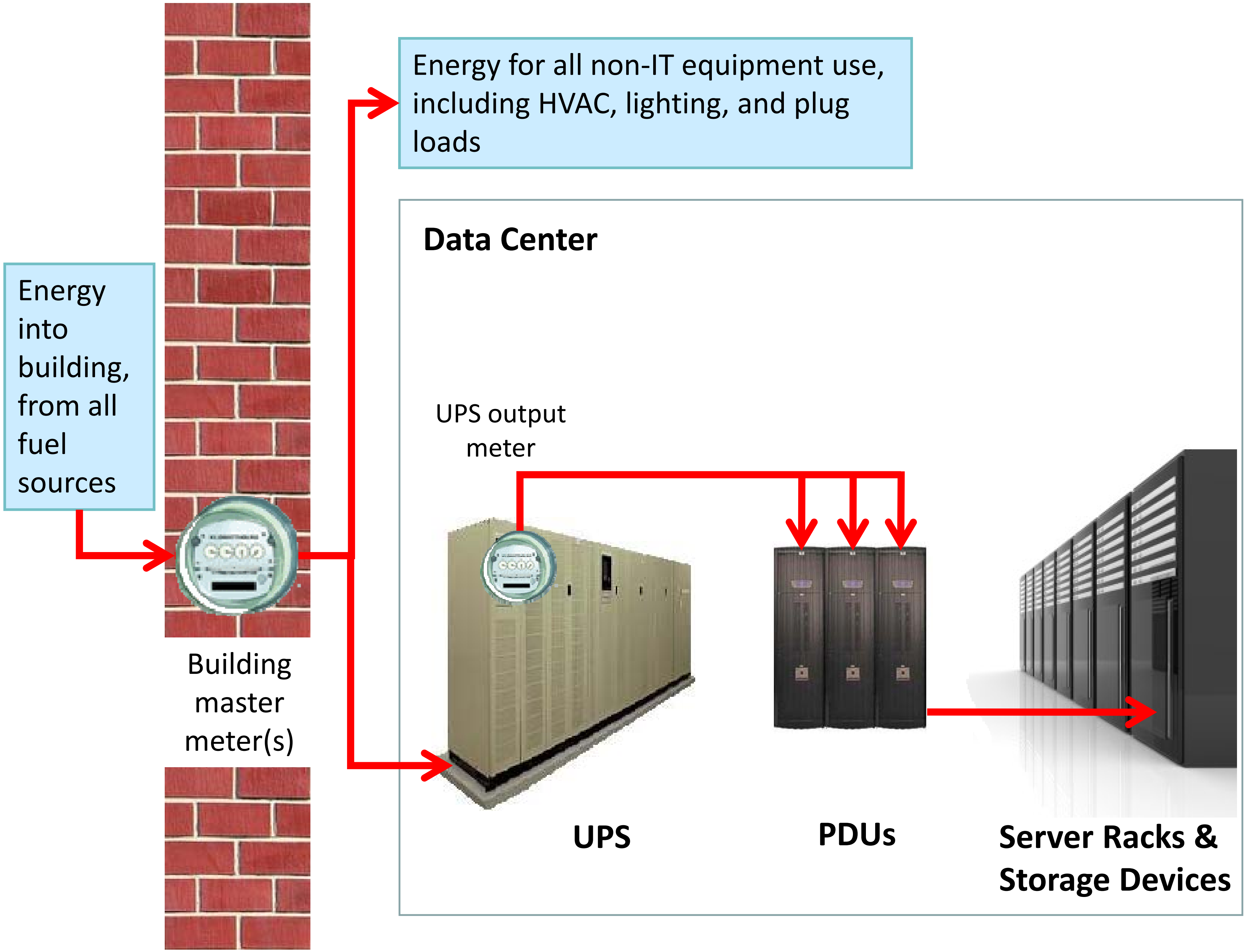
Data Center Equipment

- UPS = Uninterruptible Power Supply
  - Delivers constant power to IT equipment 24/7
  - Standard piece of equipment
  - IT equipment is powered by UPS to protect it from any fluctuations in power coming from utility
- PDU = Power Distribution Unit
  - PDU takes energy from the UPS and delivers to individual IT equipment
- Servers, Storage Silos
  - IT equipment that actually performs the computing functions of the facility

Data Center
How to measure PUE?

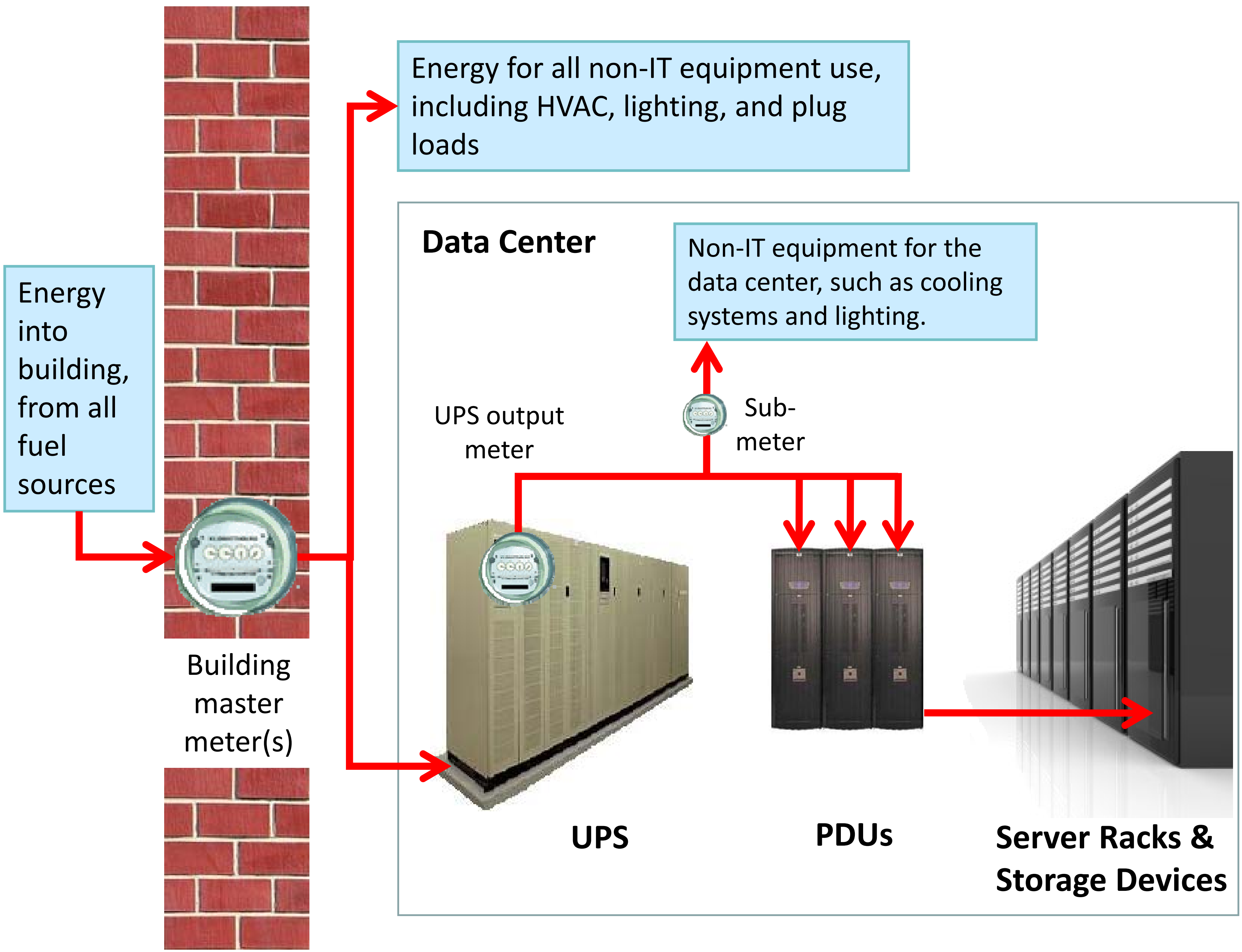
- Total Energy
  - Simple – from utility bills
- IT Energy
  - More complex – wide variety of equipment and metering configurations
  - Meters closer to the servers (e.g. measure the line going into ***each*** server), closest to pure IT load
  - Meters further from servers include loses in power supply, transformers, etc.
  - Industry experts with sophisticated operations would prefer the closest measure possible
  - ENERGY STAR needs to select the measure that is most commonly available (easiest) to maintain broad applicability

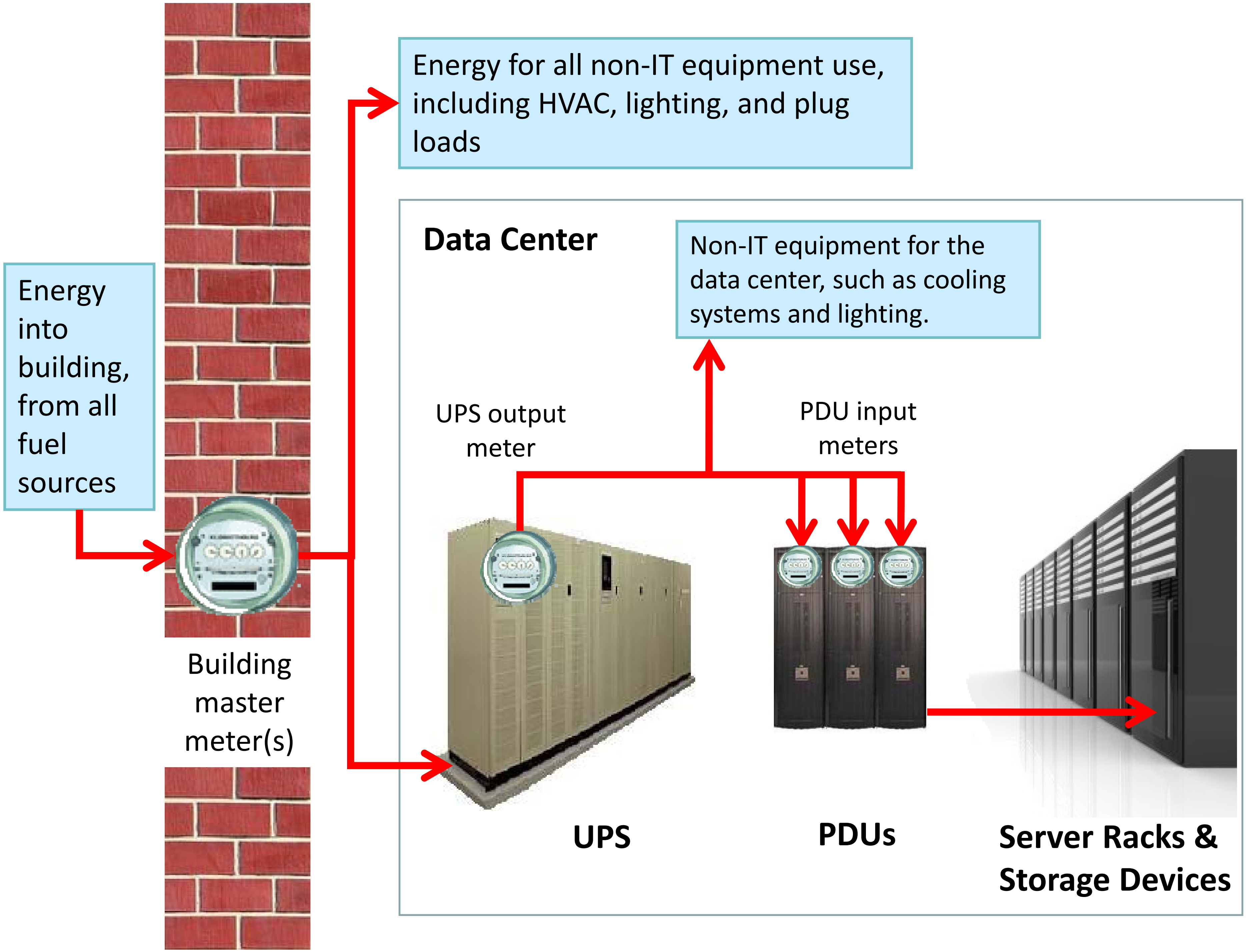
→ ***EPA will measure IT at the UPS Output***


Energy for all non-IT equipment use, including HVAC, lighting, and plug loads
Energy into building, from all fuel sources
Data Center
UPS output meter
Building master meter(s)
UPS
PDUs
Server Racks & Storage Devices

Data Center
How to measure PUE?

- EPA measures PUE at the UPS Output
  - Consistent with the technical analysis providing the most accurate rating
- EPA allows exceptions
  - Exception 1 = facilities with ***no*** UPS
    - Alternate measurement point= PDU input
  - Exception 2 = facilities with ***non-IT load that is more than 10%*** of the total UPS energy
    - Alternate measurement point = PDU Input
    - Alternate measurement option = sub-meter and subtract non-IT loads


Energy for all non-IT equipment use, including HVAC, lighting, and plug loads
Data Center
Non-IT equipment for the data center, such as cooling systems and lighting.
Energy into building, from all fuel sources
UPS output meter
Sub-meter
Building master meter(s)
UPS
PDUs
Server Racks & Storage Devices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Energy into building, from all fuel sources
UPS output meter
PDU input meters
Building master meter(s)
UPS
PDUs
Server Racks & Storage Devices

Data Center Model

- Data Source:
  - EPA Data Collection with Industry
- Dependent Variable:
  - Power Usage Effectiveness (PUE)
- Independent Variable:
  - Uninterruptible Power Supply (UPS) Source Energy

How is a score computed?

- PM user enters:
  - Whole building energy use
  - IT Energy use – measured at UPS Output
- PM computes:
  - Actual PUE
    - Whole building source energy/UPS source energy
  - Predicted PUE
    - Based on regression = expected PUE based on given UPS output energy
- PM compares actual PUE to predicted PUE
  - Actual < Predicted = more efficient ☺
  - Actual > Predicted = less efficient ☹
  - Comparison mapped to 1-to-100 scale

Economizer Rating Example

- Two example buildings
  - Same UPS Energy, Size, Climate
  - Same Predicted PUE
  - Facility with economizer has lower Total Energy and Actual PUE
  - Different ratings

	No Economizer	With Economizer
UPS Energy (MBtu)	220,000	220,000
Total Energy (MBtu)	380,000	360,000
Predicted PUE	1.87	1.87
Actual PUE	***1.73***	***1.64***
Rating	***60***	***70***

Portfolio Manager Requirements

Portfolio Manager Inputs

1. Floor Area of data center
2. IT Energy Configuration (dropdown menu)
3. IT Energy Consumption (kwh, NOT kw)
4. Optional characteristics
   - Cooling system redundancy
   - IT equipment redundancy

Define IT Energy Configuration

- What is it?

  Assesses how the Uninterruptible power supply is used and determines how IT Energy must be entered into Portfolio Manager

- What to expect in PM: (dropdown menu options)
  - Uninterruptible Power Supply (UPS) Meter supports only IT Equipment (**preferred**)
  - UPS Meter includes non-IT load of 10% or less
  - UPS Meter includes non-IT load greater than 10%. Non-IT load is sub-metered.
  - UPS Meter includes non-IT load of greater than 10%. Non-IT load is **not** sub-metered.
  - Facility has no UPS meter
  - IT Energy is not metered – Apply Estimates

Define IT Energy Configuration (cont'd)

- Meter required at either the UPS Output or PDU Input
- Users may need to install new energy meters for IT
- Last option is to apply estimates
  - Can only be applied to buildings with data centers whose square foot is 10% or less of the total square footage
  - Intended for buildings with no IT meter
  - Only permitted for 2 years (until June 2012), after which IT energy measurements are required
  - ***Are*** permitted for label applications (until June 2012)
  - After June 2012 this option will be removed from PM

Screen Mock-up

*Required for Benchmarking What is this?				
Space Attribute	Space Attribute Value (Temporary values should only be used if an Actual value is not currently known) What is this?	Use Default Value	Units	Effective Date (when this Attribute Value was first true) What is this? (MM/DD/YYYY)
*Gross Floor Area	For Temporary Use?	N/A	Sq. Ft.	

*Required for Benchmarking What is this?	
IT Energy Configuration	Effective Date (when this Attribute Value was first true) What is this? (MM/DD/YYYY)
*Select the IT Energy Configuration present at this facility: Uninterruptible Power Supply (UPS) supports only IT equipment.	

IT Energy (kWh) must be entered as follows to obtain a Rating:

IT Energy from the UPS Meter is required.
IT Energy from the PDU Meter is optional.

Measuring IT Energy Consumption

- IT Energy Meter(s)
  - Functionality similar to energy meters but analogous to operational characteristics in office buildings
    - Enter monthly energy readings
    - 12 months of data required for rating
  - Display in separate table on the Space Attribute Page
  - Must be entered in kWh (***energy*** not power)
  - Can be measured at UPS Output (**preferred**) or PDU Input meters
  - Type of meter that is required is identified based on IT Energy Configuration
  - No limit on number or type of meters

Screen Mock-ups

IT Energy Meters Add Meter				
Meter Name	**Meter Type**	**Energy Type**	**Last Meter Entry (End Date)**	**Alerts**
No Meter Defined				

Optional (not used for Benchmarking)			
Space Attribute	**Value**	**Units**	**Effective Date (when this Attribute Value was first true) What is this? (MM/DD/YYYY)**
UPS System Redundancy	N	No Units	
Cooling Equipment Redundancy	N	No Units	

EPA

Mixed Use Buildings

- ENERGY STAR Score is for the ***whole building***
  - Data Center floor area should include area with servers ***and*** all supporting areas (rooms with cooling equipment, batteries, etc)
  - Data Center does ***not*** need to be separately metered
  - IT energy (UPS Output reading) is still required
  - Whole building energy bills should be input
  - No minimum or maximum size for the Data Center
  - Data Center should not be used for server closets or computer training areas
- One score for the entire building
- One label for the entire building

Summary

Data Center Summary Facts

- Data Centers now eligible to earn the ENERGY STAR
- ENERGY STAR score and label are for a whole building
  - A building with a data center should earn a single score
  - It is not necessary for a building to sub-meter a data center to earn a score
- ENERGY STAR score is based on PUE
  - Power Usage Effectiveness
  - Total Source Energy/IT Source Energy
  - IT energy measured at the UPS Output
- Some buildings will have to install new IT energy meters
  - These buildings will be allowed to use estimated values until meters fully installed
  - Estimates only permitted for up to two years (June 2012)

Quiz

- Question: What is PUE?
- Answer:
  - PUE is a measure of data center infrastructure efficiency
  - It is defined as total energy divided by IT energy

- Question: Where should I measure IT Energy?
- Answer:
  - IT Energy should be measured from the output of your uninterruptible power supply (UPS)

- Question: What do I do if I don't have a UPS meter installed?
- Answer:
  - You are required to install one… but…
  - EPA will allow you to use estimated values while you are in the process of installing your meter
  - Estimates will be permitted only until June 2012

- Question: How do I measure IT Energy if my Data Center does not have a UPS?
- Answer:
  - If your facility has no UPS, you should measure IT energy at the input of your Power Distribution Unit (PDU)

- Question: Can I get a score for a Data Center located in a larger building?
- Answer:
  - No
  - ENERGY STAR provides ratings for whole building, you must enter energy and operational information for the entire building in order to obtain a single score

Questions?

Frequently Asked Questions

The following questions will be provided in the PM FAQ sections and are supplied here fore your reference

What is the definition of "Data Center"?

Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data Center functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities. Often Data Centers are free-standing, mission-critical computing centers. When a Data Center is located within a larger building, it usually has its own power and cooling systems. The Data Center space is intended for sophisticated computing and server functions; it should not be used to represent a server closet or computer training area.

For more information, please refer to Portfolio Manager Help.

Should my server closets, computer training areas, telecom closets, or print/copy rooms be listed as "Data Center" space?

No, these are not defined as "Data Center". In Portfolio Manager, these spaces should be included in the total gross floor area input for the building's main space type (e.g., Office). The Data Center space type is intended for sophisticated computing and server functions which typically include high density computing equipment, dedicated cooling systems, and uninterruptible power supplies (UPS).

For more information on what is defined as "Data Center" space, refer to FAQ: *What is the definition of "Data Center"?*

What is the Power Usage Effectiveness (PUE) metric for a Data Center and how is it calculated?

Power Usage Effectiveness (PUE) is a standard measure of facility infrastructure efficiency in the IT industry. It is equal to the total energy consumption of a Data Center (for all fuels) divided by the energy consumption used for the IT equipment. That is:

PUE = Total Facility Source Energy/ IT Source Energy

The PUE generally ranges from 1.25 to 3.0 for most Data Centers. PUE is a measure of how much energy is consumed by the power supply and cooling systems in a Data Center relative to the amount of energy delivered directly to the IT equipment. For more information on PUE, refer to White Paper 22 by The Green Grid, *Usage and Public Reporting Guidelines for The Green Grid's Infrastructure Metrics PUE/DCiE* http://www.thegreengrid.org/Global/Content/white-papers/Usage%20and%20Public%20Reporting%20Guidelines%20for%20PUE%20DCiE.aspx

In Portfolio Manager, PUE is calculated by dividing the total energy for the building from all fuel sources (in source kBtu) by the annual IT energy consumption as measured at the output of the UPS meter (converted to source kBtu). PUE is only available for free standing Data Centers, and not for Data Centers located within larger buildings. This is because sub-metering is not required in Portfolio Manager, so the "Total" energy of the Data Center may not be known.

Where should I measure the IT energy consumption to get a Data Center rating?

IT Energy readings should be taken at the output of the Uninterruptible Power Supply (UPS). In the dataset used to create rating methodology for Data Center, IT energy was measured at the output of the UPS. Thus, a measurement at this location will provide the most accurate rating. The UPS output is a standard, uniform measurement location available to all Data Center owners. Many UPS systems already have energy consumption meters on them. In this case you will just need to begin tracking this consumption month to month. However, if your facility does not have an energy meter installed at the UPS, you will need to install one to obtain the most accurate rating.

There are two exceptions to the UPS output requirement: first, if there no UPS system; and second, if the UPS system supports non-IT loads that amount to more than 10% of its load (e.g., cooling equipment) and cannot be sub-metered. In both of these cases, you should provide the IT energy consumption measured at the input to the Power Distribution Unit (PDU).

For more information on the location of the IT measurement refer to the FAQ: Why can't I measure my Data Center IT load closer to the actual IT equipment, like at the PDU output or at individual servers? And: Can I still get a rating for my Data Center if I have not yet recorded 12 months of IT energy?

Can I get a rating that applies just to a Data Center located within a building?

No.

The energy performance ratings are designed to assess whole building energy consumption. If you have a larger commercial building (e.g., Office) that contains a Data Center, you should enter the entire building. Within Portfolio Manager you should enter two spaces: Office and Data Center. Enter the appropriate data in the required fields for each space, and then enter your total building energy consumption. Portfolio Manager will provide a single rating for the building.

How do I reclassify space incorrectly entered as Computer Data Center?

If you have incorrectly classified your server closets or computer training rooms, for example, as Computer Data Center space, you must delete this space from the building and add the square footage back into the primary space entry for the building (e.g., Office). If you are not sure whether your Data Center space is correctly classified, refer to the FAQ "What is the definition of "Data Center?"

Follow these steps to complete the change in Portfolio Manager:

- Click on the Office space (or the building's other primary space entry) to edit the space attributes. Select "Edit" for the Gross Floor Area from the far right column.
  - Click the radio button for "Correct."
  - Add the square footage of the Data Center space to the Gross Floor Area of the Office or other primary space entry.
  - DO NOT update the "Effective Date" to today's date; leave the previously-input Effective Date as-is.
  - Click "Save" to return to the page for the space.
- If the building's Office or other main space entry has a revision history showing different Gross Floor Areas for different points in time, be sure to also add the Computer Data Center square footage to each Gross Floor Area entry in the revision history so that the square footage appears as part of your building for all points in time. Again, do not change the Effective Date when making this correction.
- Click "Save" once more to go back to the "Facility Summary" page.
- In the "Space Use" table, click "Delete Space" for the Data Center space and confirm the deletion.

Analysis of Expected Rating Changes – June 2010 Portfolio Manager Release

This report is for internal use by EPA only – Do not distribute externally

This report summarizes expected rating changes due to the application of new models starting on June 7, 2010. A large percent of Portfolio Manager users will be affected by the following four changes:

I. New Data Center performance rating scale
II. New calculations on Square Feet and Personal Computer Density for Office model
III. New calculations on Register Density for Retail model
IV. Updates to Parking Space adjustment

This document presents the details of each change, including its anticipated affect on scores. These results are based on an analysis of Portfolio Manager data pulled in the course of development, on January 24, 2010. As building data may have changed over the ensuing months, exact changes may differ from these projections.

I. Data Center Changes

Data Center Rating Changes

The initial report provided by SRA included 13,869 buildings with Data Centers. A basic set of filters was established by EPA to remove extreme/questionable data from the analysis. A complete list of filters is provided in **Attachment A**. After the filters, a total of 11,316 buildings were analyzed.

- The average change across all 11,316 data center buildings is +5 points
    - 17% experience a decrease, with an average of -4 points
    - 67% experience an increase, with an average of +9 points
    - 16% experience no change
- **Figure 1** presents the distribution of rating changes for Data Centers. The distribution is close to normally distributed about zero with a positive skew, indicating that the majority of buildings experienced a rating increase. The majority of changes are within +/-10 points.
    - Over 56% of the buildings change within +/- 3 points
    - Over 80% of the buildings change within +/- 10 points
- The 11,316 buildings with Data Centers represent different types of buildings. **Table 1** below shows the breakdown of building types with data centers and the average rating change for each building type.
- The current model does not allow buildings with Data Centers that are larger than 10% of the total floor space to receive ratings. These buildings will be eligible to receive a rating after the new model is released on June 7, 2010. **Table 2** shows a count of these buildings by Building Type.

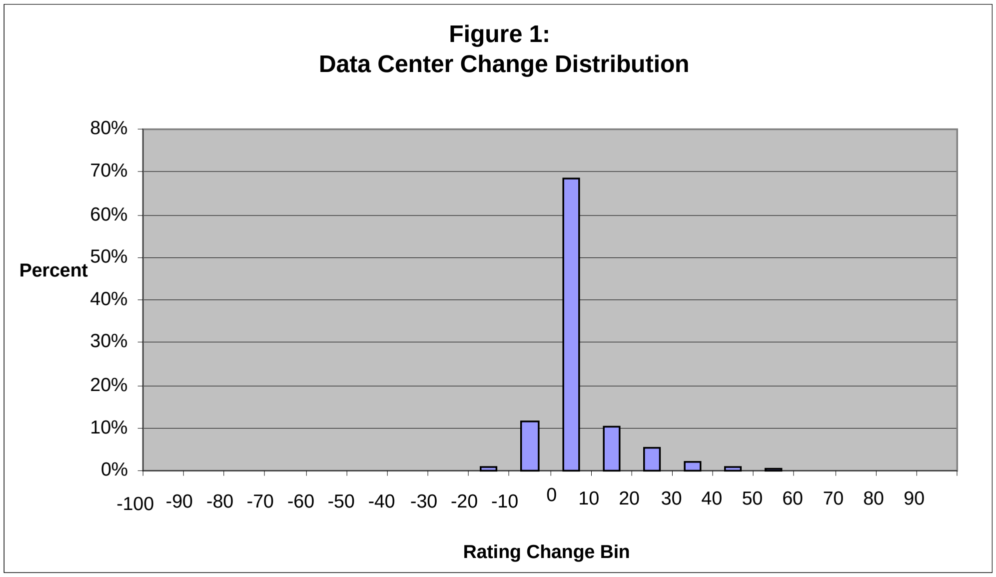


Table 1 Data Center Breakdown By Building Type		
Building Type	**Count**	**Average Rating Change**
Office	7452	7
K-12 School	2597	2
Hospital (Acute Care or Children's)	594	2
Bank/Financial Institution	260	7
Hotel	157	0
Courthouse	84	2
Medical Office	84	6
Warehouse (Unrefrigerated)	54	7
Supermarket/Grocery	12	NA
Other	6	NA
Retail	6	NA
Residence Hall/Dormitory	4	NA
House of Worship	3	NA
Warehouse (Refrigerated)	2	NA
Distribution/Shipping Center	1	NA
Averages not shown for types with fewer than 50 buildings		

Table 2 Data Centers That Are Larger than 10% of Floor Space Breakdown by Building Type	
Building Type	**Count**
Office	210
Other	127
Warehouse (Unrefrigerated)	3
Medical Office	3
Bank/Financial Institution	2
Hospital (Acute Care or Children's)	1

Data Center Label Eligibility

At the time when the data was pulled (January 24, 2010), 2,211 of the buildings with Data Centers in the analysis had earned the label.

- Recent winners – Out of the 1,791 that have earned a label in 2008 or 2009:
    - 1,686 buildings have ratings of 75 or higher prior to the change
        - 1,609 will continue to have ratings of 75 or higher after the release
        - 77 will have ratings that drop below 75 ***these buildings will lose their current label eligibility***
    - 105 buildings actually have ratings below 75 prior to the change
        - 58 will see an increase with the release, bringing the rating to 75 or higher
        - 47 will continue to have ratings below 75 after the release

Data Center Technical Details

A new Data Center model has been developed. Basic characteristics of the new rating model are as follows:

- **Data**: The new model is based on a data collection effort led by EPA in consultation with stakeholders and industry leaders.
- **Dependent Unit of Analysis**: The new model is based on Power Usage Effectiveness, or PUE. This variable is unique to the Data Center space type. Source energy use intensity (source EUI) is used for the majority of EPA's rating models, but was not considered to be the best choice for a Data Center model. Source EUI can vary widely for data center facilities, and does not take into consideration the varying densities of IT equipment that can be present in these facilities. PUE is a standard measure of facility infrastructure efficiency in the IT industry. It is equal to the total energy consumption of a Data Center (for all fuels) divided by the energy consumption used for the IT equipment. This is a measure of how much energy is consumed by the power supply and cooling systems in a Data Center relative to the amount of energy delivered directly to the IT equipment.
- **Independent Variable** – There is one independent variable in the Data Center model (refer to following section for complete input requirements). This variable is the IT Energy, or the energy used to power the IT equipment. This is a unique attribute for Portfolio Manager .because the IT Energy is actually read from an energy meter that is a sub-meter within the building.

Prior to June 7, only buildings with Data Centers that are 10% or less of the floor area have ratings in Portfolio Manager. After June 7, these will still be the only Data Center buildings to see ratings. This is because no buildings will have information for the new IT Energy meter, which is required for an accurate rating. ***In recognition of this new requirement, EPA will provide estimated values for Data Center energy consumption to ensure that buildings that have ratings now still have ratings after the change.*** The estimated values used for this calculation will only be available in Portfolio Manager until June 2012, after which time IT Energy meters will be required. The average rating change for the buildings that will be given estimates is approximately +7 points.

Buildings with Data Centers that are larger than 10% of the floor area do not currently have ratings, will not be given estimated values, and therefore will not have ratings on June 7. They will be able to get ratings only once they enter IT Energy data.

In general, buildings that currently have ratings and have data centers should expect an increase in rating because the new estimates are more appropriate for the current state of the IT industry. The old estimates were implemented in 2004 and were conservative adjustments. The new estimates are based on the more recent data collection, which provides a greater allowance for the energy intensity of Data Centers.

In addition to this overall positive trend, the following behavior is noted:

- **Percentage of the building that is Data Center**: Buildings with a larger percentage of Data Center space will see larger increases in ratings.
    - The majority of Data Centers, approximately 85%, have less than 5% of their floor area classified as Data Center and have an average rating change of +6 points
    - Buildings with Data Centers that are between 5 and 10% of the floor area represent about 15% of the sample.
        - These buildings are likely to see larger increases of approximately +20
        - These buildings also tend to have *office* computer density and worker density that is 25-30% larger than the office spaces in buildings with smaller data centers. This suggests that these buildings may be entering too many computers in their office space. They may be entering computers in their office space as a means of overcompensating for the perceived needs of their data center. ***Computers and equipment in a data center should not be counted in an office, as this is double counting***. It is quite possible that some of these facilities are incorrectly using Data Center space and/or adding extra workers and computers within their office.

<u>Data Center User Inputs</u>

The official definition of Data Center has been modified to ensure that it is clear when this space type should be used:

> *Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data Center functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities. Often Data Centers are free standing, mission critical computing centers. When a data center is located within a larger building, it will usually have its own power and cooling systems. The Data Center space is intended for sophisticated computing and server functions; it should not be used to represent a server closet or computer training area.*

It is highly likely that there are many Data Centers in Portfolio Manager that have not been correctly classified (e.g. small server rooms or computer training areas). These spaces will have to be re-classified (deleted and the square foot combined with the larger primary space such as Office). An FAQ has been developed to guide users through this process. If a Data Center space is misclassified it is likely to see a rating increase on June 7^{th}, when the changes go live. However, the rating will decrease after the space is re-classified. The net change (after they reclassify) will be approximately -3 points. Effectively these spaces are using Data Center incorrectly (under the old or new system), resulting in unduly high ratings. Thus, when they are properly classified along with the main primary space, a slight rating decrease is expected.

There are three required inputs and two optional inputs for Data Center.

1. Gross Floor Area (required)
    a. The total gross floor area is measured between the principal exterior surfaces of the enclosing fixed walls and includes all supporting functions for the Data Center. This should include the entire Data Center for stand alone facilities, which may have raised floor computing space, server rack aisles, storage silos, control console areas, battery rooms, mechanical rooms for cooling equipment, administrative office areas, elevator shafts, stairways, break rooms and restrooms. When a Data Center is located within a larger building, the total gross floor area should include the computing space as well as any mechanical rooms or office spaces that support the Data Center.
    b. The Gross Floor Area will be a field which can be entered in ft^2 or m^2 as for other space types.
2. IT Energy Configuration (required)
    a. The IT Energy Configuration designates the location where the IT Energy consumption will be measured. The preferred location of this measurement is at the output of the Uninterruptible Power Supply (UPS) meter. Please refer to the definition of IT Energy for other meter locations which are permitted under certain conditions when UPS readings are not available.
    b. The IT Energy Configuration will be selected from a drop-down menu. There are 6 options:
        i. Uninterruptible Power Supply (UPS) supports only IT Equipment. ***(preferred)***
        ii. UPS includes non-IT load of 10% or less.
        iii. UPS includes non-IT load greater than 10%. Non-IT load is sub-metered.
        iv. UPS includes non-IT load greater than 10%. Non-IT load is not sub-metered.
        v. Facility has no UPS.
        vi. IT Energy is not currently metered at this facility – Apply estimates.
            1. ***Note that Estimates will only be permitted until June 2012, and only for Data Centers that are less than 10% of the building floor area.***
3. IT Energy Meter (required)
    a. The IT Energy is defined as the total amount of energy required by the server racks, storage silos, and other IT equipment in the Data Center. For the purposes of ENERGY STAR this should be measured at the output of the Uninterruptible

Power Supply (UPS). A measurement of IT Energy from the UPS output is consistent with a Level I measurement of data center Power Usage Effectiveness, or PUE.

   i. These measurements should be taken as energy readings, in kWh. They should not be instantaneous power readings. Input fields permit readings for a user-determined measurement time period (e.g. weekly, monthly, or quarterly). Monthly measurements are recommended, roughly on schedule with utility readings, if possible.
   ii. Facilities that do not have a UPS are permitted to supply readings from a Power Distribution Unit (PDU) or alternate location. In these cases, readings should be made from the input of the PDU, or the first available measurement point. For consistency, if the measurements are available at the PDU input, they should be reported in favor of rack-level or other measurements.
   iii. Facilities for which more than 10% of the UPS load is directed to non-IT (e.g. mechanical) equipment are required to provide a reading that excludes the non-IT equipment. Two options are permitted:
      1. If energy used by non-IT equipment is measured, then it may be subtracted from the total UPS energy, and the remainder should be entered into the UPS Output Meter in Portfolio Manager
      2. If energy used by non-IT equipment is not measured, then supply a reading from the input to the PDU that support the IT equipment.

b. IT Energy will be entered in the attribute section of Portfolio Manager. However, the functionality will be similar to a typical energy meter, enabling users to enter monthly energy values.

4. Cooling Equipment Redundancy (optional)
   a. Redundant components are typically required to accommodate the Data Center in the event of equipment failure. The specific level of redundancy will depend on the Data Center and its particular functions. Please select the redundancy level that best applies to the mechanical cooling equipment. If there are multiple systems operating at different levels of redundancy, choose the option that applies to the majority of the data center cooling load.
   b. This question will have a dropdown menu with the following options:
      i. N
      ii. N+1
      iii. N+2
      iv. 2N
      v. Greater than 2N
      vi. None of the Above
5. UPS System Redundancy (optional)
   a. Redundant components are typically required to accommodate IT loads in the event of equipment failure. The specific level of redundancy will depend on the Data Center and its particular functions. Please select the redundancy level that best applies to the Uninterruptible Power Supply (UPS) at the Data Center. If there is no UPS system, indicate the redundancy for the PDUs that support the IT

load. If there are multiple systems operating at different levels of redundancy, choose the option that applies to the majority of the IT load.

b. This question will have a dropdown menu with the following options:
   i. N
   ii. N+1
   iii. N+2
   iv. 2N
   v. Greater than 2N
   vi. None of the Above

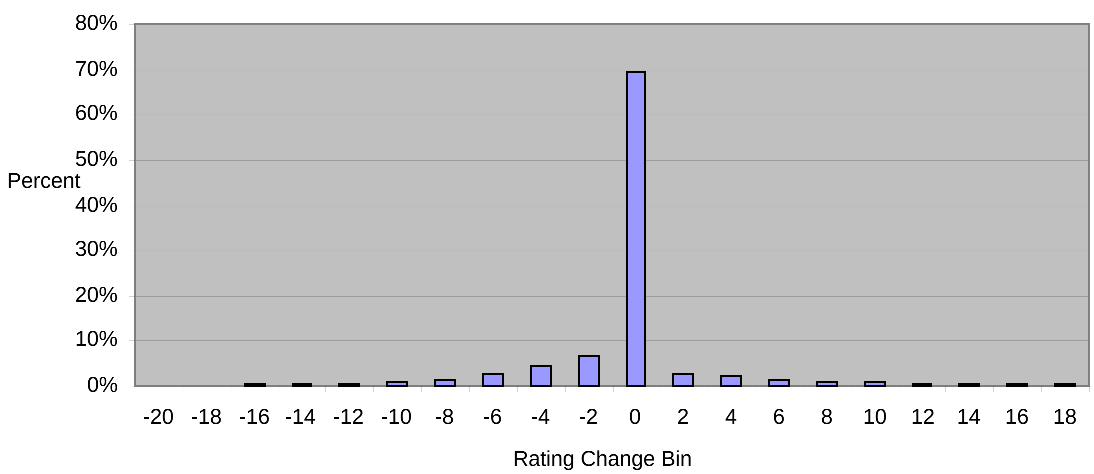
II. <u>Office Changes</u>

<u>Office Rating Changes</u>

The initial report provided by SRA included 41,419 Office buildings. A basic set of filters was established by EPA to remove extreme/questionable data from the analysis. A complete list of filters is provided in **Attachment A**. After the filters, a total of 40,338 buildings were analyzed.

- The average change across all 40,338 offices is +1 point
  - 18% experience a decrease, with an average of -5 points
  - 14% experience an increase, with an average of +10 points
  - 68% experience no change
- **Figure 2** presents the distribution of rating changes for Offices. The distribution is close to normally distributed about zero, indicating that changes are neither large nor skewed in one direction. Over 80% of building change within +/-3 points.

Figure 2:
Office Rating Change Distribution



Office Label Eligibility

At the time when the data was pulled (January 24, 2010), 3,466 of the offices in the analysis had earned the label.

- Recent winners – Out of the 2,811 that have earned a label in 2008 or 2009:
  - 2,690 buildings have ratings of 75 or higher prior to the change
    - 2,500 will continue to have ratings of 75 or higher after the release
    - 190 will have ratings that drop below 75, ***these buildings will lose label eligibility***
  - 121 buildings actually have ratings below 75 prior to the change
    - 49 will see an increase with the release, bringing the rating to 75 or higher
    - 72 will continue to have ratings below 75 after the release
- General eligibility
  - With the new rating, 14,615 of the offices in the analysis have ratings of 75 or higher ***– in other words, 36% of the Offices in Portfolio Manager are eligible for the ENERGY STAR.***
  - This compares to 14,433 eligible offices (36%) with the old rating.

Office Technical Details

The new Office model has been updated to limit adjustments for Square Feet and Personal Computer Density. Note that buildings with Office, may also have Data Center, Retail, or Open Parking and be affected by those changes, as well. Basic characteristics of the changes to the office calculation are as follows:

- **Square Foot cap**: Buildings with larger square foot values were formerly receiving large energy adjustments and higher ratings. Analysis of CBECS and Portfolio Manager has shown that it is necessary to bound the adjustment for square foot; this bound has been set at 200,000 square foot. Buildings over 200,000 square foot do not have higher EUIs than buildings that are 200,000 square foot, therefore they no longer receive an extra adjustment.
- **Personal Computer Cap**: Similarly, buildings with extremely high PC density were formerly receiving too generous of an adjustment for energy. Analysis of CBECS and Portfolio Manager has shown that it is necessary to bound the allowance for PC density; this bound has been placed at 11.1 PCs per 1,000 square foot.

As shown above, the average office building is not expected to experience a large change in rating. Correlations with rating changes are observed for the following characteristics:

- **Size**: Only Offices larger than 200,000 square foot will be affected by the new square foot calculation. These offices make up 19% of all of the office buildings in Portfolio Manager but they represent 53% of the buildings with rating changes, the majority of these buildings experience rating decreases, because their energy adjustment is now capped.
- **Data Center:** Office buildings with data centers represent approximately 19% of offices and are expected to have rating increases due to the new Data Center methodology. Their average change is approximately +7 points. The size of the increase is expected to be

bigger for buildings with data centers that represent a larger percentage of building square foot.

- **Personal Computer Density:** Only Offices with PC density above 11.1 will be affected by the new personal computer calculation. The average PC Density is only 2.4; a value over 11.1 is most likely a data entry error. Only 212 offices (0.5%) have PC Density values in that range. This small group of buildings will see a decrease, with an average of –7.6 points. The average rating before the change is 68 points, with the average rating after the change being 61 points, demonstrating that the decrease in ratings does not result in any unfair bias for these facilities.
- **Offices with Parking:** The majority of offices smaller than 20,000 square feet with open floor space parking will experience a rating decrease due to the update to the parking adjustment. The average decrease for these buildings is -1. Due to the interaction of building characteristics and the other updates there is no major trend for larger buildings with parking because the parking energy contributes a smaller percentage of the overall energy use.

Office User Inputs

There are no changes to user input requirements.

III. Retail Changes

Retail Rating Changes

The initial report provided by SRA included 17,612 Retail buildings. A basic set of filters was established by EPA to remove extreme/questionable data from the analysis. A complete list of filters is provided in **Attachment A**. After the filters, a total of 16,610 Retail buildings were analyzed.

- The average change across all 16,610 retail buildings is -1 point.
    - 10% experience a decrease, with an average of -7 points
    - 0% (4 buildings) experience an increase, with an average of 2 points
    - 90% experience no change
- **Figure 3** presents the distribution of rating changes for Retail buildings. The distribution is close to normally distributed about zero with a slightly negative skew, indicating that changes are not large but are mostly negative. The majority of changes are within +/-3 points. Over 90% of the buildings change within +/- 3 points.

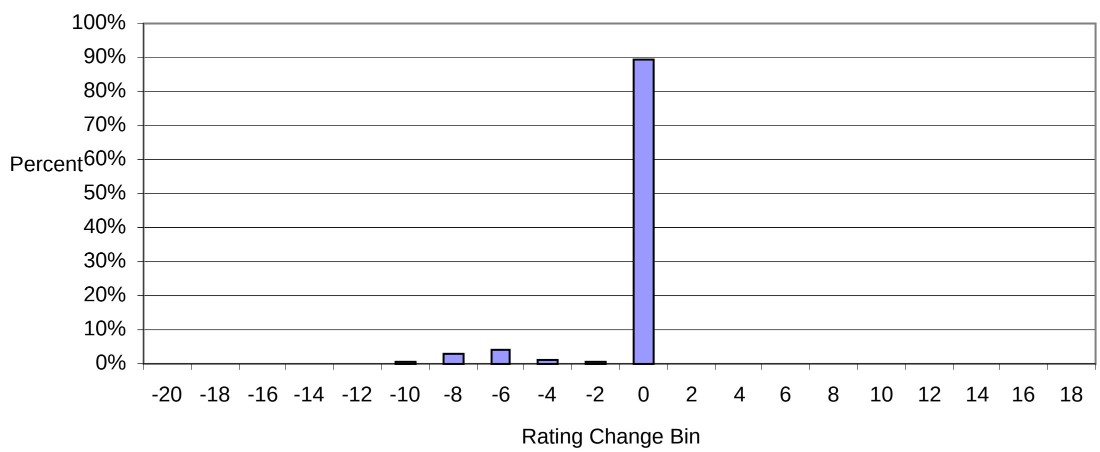
Retail Label Eligibility

At the time when the data was pulled (January 24, 2010), 509 of the retail buildings in the analysis had earned the label.

- Recent winners – Out of the 505 that have earned a label in 2008 or 2009:
    - 448 currently have and will continue to have ratings of 75 or higher
    - 31 currently have and will continue to have ratings below 75
    - 26 buildings currently have ratings above 75 which are expected to drop below 75 with the release, ***these buildings will lose label eligibility.***

- General eligibility
    - With the new rating, 5,139 of the retail facilities in the analysis have ratings of 75 or higher ***– in other words, 31% of the Retail buildings in Portfolio Manager are eligible for the ENERGY STAR.***
    - This compares to 5,501 eligible retail buildings (33%) with the old rating.

Figure 3:
Retail Rating Change Distribution



<u>Retail Technical Details</u>
The new Retail model has been updated with a cap on Register Density. Note that buildings with Retail may also have Office, Data Center, or Open Parking and be affected by those changes, as well. Basic characteristics are as follows:

- **Register Density cap**: Analysis of CBECS and Portfolio Manager has shown that buildings with very high values for register density were receiving too generous of an adjustment within Portfolio Manager. While buildings with higher densities do need an allowance, over a certain value the trend levels off and an additional adjustment is not necessary. Thus, similar to the bound for PC Density in Offices, the retail calculation for register density has been bounded at 0.71 registers per 1,000 square foot. This value is well above the average value, representing the 98th percentile within CBECS. Thus, it is a small number of retail stores.

Overall, the average Retail rating decreased by approximately -1 point. The rating change for each building depends on the interaction of all of the updates. Correlations with rating changes are observed for the following operating characteristics:

- **Register Density:** Only buildings with register density above 0.71 are affected by the calculation change. The average Register Density is only 0.3; a value over 0.71 is most likely a data entry error or data referencing hand held point of sale devices, and not true registers. A total of 188 buildings (or, 1%) have register density above 0.71; their average change is -18 points. Prior to the release, the average rating is approximately 87 points, hence the 18 point decrease is appropriate for these facilities, bringing the new average rating to 69, which is still above average.

- **Parking:** Only 1,590 retail buildings have open parking areas (about 10% of the retail sample). These buildings are more likely to experience a decrease due to the correction in the Open Parking calculation. The larger the parking lot is relative to the size of the building, the greater the decrease in rating.
  - The average rating change for all retail buildings with parking was -6.
    - For parking areas that are either less than 200,000 square foot or less than 60% of the building floor area, the average change is only -3.

Retail User Inputs

There are no changes to user input requirements.

IV. Parking Changes

Parking Rating Changes

The initial report provided by SRA included 16,781 buildings with Parking. A basic set of filters was established to remove extreme data from the analysis. A complete list of filters is provided in **Attachment A**. After the filters, a total of 13,580 buildings were analyzed.

- The average change across all 13,580 buildings with parking is -3 points
  - 81% experience a decrease, with an average of -4 points
  - 19% experience no change
- **Figure 4** presents the ratings changes for buildings with Parking. The distribution is one sided with a maximum at zero and centered around -1, indicating that most facilities with parking experience a small rating decrease. The majority of changes are within +/-2 points.
  - Over 37% of buildings change within +/- 1 point
  - Over 52% of buildings change within +/- 2 points
  - Over 97% of buildings change within +/- 10 points
- The 13,580 buildings with Parking represent different building types. **Table 3** below shows the average rating change for each building type.

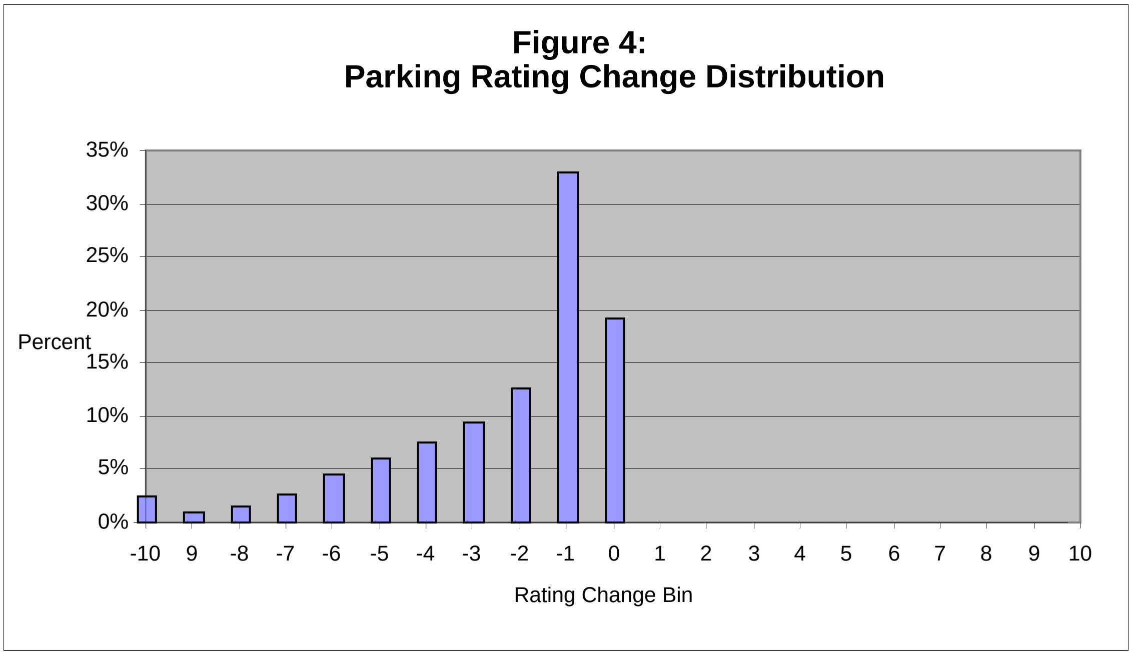


Table 3 Parking Breakdown By Building Type		
Building Type	**Count**	**Average Rating Change**
Office	6523	-2
K-12 School	3416	-4
Retail	1621	-6
Hospital (Acute Care or Children's)	678	-1
Hotel	592	-1
Bank/Financial Institution	220	-4
Medical Office	203	-3
Warehouse (Unrefrigerated)	122	-4
Courthouse	106	-3
Supermarket/Grocery	40	NA
Residence Hall/Dormitory	38	NA
House of Worship	13	NA
Warehouse (Refrigerated)	8	NA
Averages not shown for types with fewer than 50 buildings		

Parking Label Eligibility

Label Eligibility information is not specifically available for Parking because Parking is not a primary building type and because the parking correction was added to the release after the initial data pull.

Parking Technical Details

The change in the parking lot calculation is a correction to a defect in the tool. The coefficient for the lighting allowance at an open parking lot was incorrect (too high). This has been corrected. Because the new coefficient is smaller, buildings with Open Parking are expected to see a decrease in rating, as was shown above.   There are *no changes* to the calculations for enclosed or partially enclosed parking structures. The change only affects open parking lot.

There are a few trends with respect to building characteristics

- **Relative Size of Open Parking –** The effect of lowering the adjustment for parking will be more evident in buildings with parking areas that are larger, especially in comparison to the main building. While the average decrease is -3 points overall, it is only -2 points for those buildings where Open Parking square footage is less than 60% of the size of the building.
- **Building Type –** Certain building types are more likely to have smaller buildings with larger open parking lots.   Because the open parking is comparatively large for these buildings, they are more likely to see a rating decrease. These building types are: Retail, School, Bank, Worship, and Warehouse. As shown in Table 3, they have bigger average decreases because of this typical building configuration.

Parking User Inputs

There are no changes to user input requirements.

Attachment A –Filters for Analysis

Data Center Filters for Analysis		
Condition for Including a Record in the Analysis	**Records Removed**	**Records Remaining**
Building includes Data Center	--	13,869
Building received a rating	2,385	11,484
Source EUI >= 10	125	11,359
Source EUI <= 3,000	43	11,316
All Initial Filters	**168**	**11,316**

Office Filters for Analysis		
Condition for Including a Record in the Analysis	**Records Removed**	**Records Remaining**
Building Type = Office, Bank/Financial Institution, Courthouse	--	41,419
EUI > 10	410	41,009
EUI < 3000	330	40,679
Worker Density < 50	306	40,373
Walk-in Density < 0.2	23	40,350
Building Received a Rating	12	40,338
All Initial Filters	**1,081**	**40,338**

Retail Filters for Analysis		
Condition for Including a Record in the Analysis	**Records Removed**	**Records Remaining**
Building includes Retail space	--	17,612
Building Type = Retail	647	16,965
Number of Primary Spaces = 1	156	16,809
Building Receives a Rating	0	16,809
EUI > 10	76	16,733
EUI < 3000	25	16,708
Worker Density > 0.2	98	16,610
Worker Density < 50	0	16,610
PC Density <50	0	16,610
All Initial Filters	**1,002**	**16,610**

Parking Filters for Analysis		
Condition for Including a Record in the Analysis	**Records Removed**	**Records Remaining**
Building includes Parking	--	16,781
Building Receives a Rating	3,053	13,728
EUI > 10	100	13,628
EUI < 3000	48	13,580
All Initial Filters	**3,201**	**13,580**

ENERGY STAR Rating for Data Centers
Frequently Asked Questions

EPA's energy performance rating system helps energy managers assess how efficiently their buildings use energy, relative to similar buildings nationwide. Organizations can obtain energy performance ratings through Portfolio Manager, an interactive energy management tool that allows users to track energy and water consumption of buildings in a secure online environment. The energy performance of a building is expressed on a 1-to-100 scale — a rating of 50 indicates that the building performs better than 50% of all similar buildings, while a rating of 75 indicates that the building performs better than 75% of all similar buildings. EPA released a 1-to-100 energy performance rating for data centers in Portfolio Manager on June 7, 2010. The questions below are designed to help data center owners and operators better understand the rating and benchmark their buildings in Portfolio Manager.

What is the definition of "Data Center"?

Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data Center functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities. Often Data Centers are free-standing, mission-critical computing centers. When a Data Center is located within a larger building, it usually has its own power and cooling systems. It is also common to have raised floor space to facilitate equipment cooling. The Data Center space is intended for sophisticated computing and server functions; it should not be used to represent a server closet or computer training area.

What dataset was used to create the ENERGY STAR rating for Data Centers?

Because there is no known national data set available on the market for understanding energy consumption in Data Centers, the data used to create the ENERGY STAR rating for Data Centers is based on an EPA-led data collection effort. In late 2007, EPA began working with stakeholders and industry leaders, and by the summer of 2009, EPA had collected complete energy consumption and operating data from 120 Data Centers representing various sizes, types, and locations. The regression model was developed using data from stand-alone Data Centers, but rating results for Data Centers located within larger buildings (e.g., office building) were found to be consistent with the stand-alone results.

Does the Data Center rating adjust for the climate effects of geographic location?

No. Analysis of Data Center energy consumption reveals that there is no significant difference in the energy consumption of Data Centers from different locations in the country. The energy required to cool the IT equipment of a Data Center can be 10 times the amount of energy required by outdoor air temperatures. It is these internal loads - not outdoor conditions – that dominate the Data Center's energy consumption. Hence, the typical Data Center does not show different energy consumption during different months or seasons of the year.

The performance rating scale for Data Centers is based on observed energy consumption. Therefore, modifications that reduce energy consumption will increase the ENERGY STAR rating. This may include modifications such as improvements in ventilation or the installation of an air-side economizer. The scale is not specifically designed to award points for these technologies. However, if they are installed and operated correctly and lower the Data Center energy use, then the ENERGY STAR rating will be higher.

What is the Power Usage Effectiveness (PUE) metric for a Data Center and how is it calculated?

Power Usage Effectiveness (PUE) is a standard measure of facility infrastructure efficiency in the IT industry. It is equal to the total energy consumption of a Data Center (for all fuels) divided by the energy consumption used for the IT equipment. That is: PUE = Total Facility Source Energy/ IT Source Energy.

The PUE generally ranges from 1.25 to 3.0 for most Data Centers. PUE is a measure of how much energy is consumed by the power supply and cooling systems in a Data Center relative to the amount of energy delivered directly to the IT equipment. For more information on PUE, refer to The Green Grid paper: *Usage and Public Reporting Guidelines for The Green Grid's Infrastructure Metrics PUE/DCiE*. In Portfolio Manager, PUE is calculated by dividing the total energy for the building from all fuel sources (in source kBtu) by the annual IT energy consumption as measured at the output of the UPS meter (converted to source kBtu).

Where should I measure the IT energy consumption to get a Data Center rating?

IT Energy readings should be taken at the output of the Uninterruptible Power Supply (UPS). In the dataset used to create rating methodology for Data Center, IT energy was measured at the output of the UPS. Thus, a measurement at this location will provide the most accurate rating (see “A” in figure below). The UPS output is a standard, uniform measurement location typically available to Data Center owners. See the schematic below of where a UPS meter may be placed. Many UPS systems already have energy consumption meters on them. In this case you will just need to begin tracking this consumption month to month. However, if your facility does not have an energy meter installed at the UPS, you will need to install one and begin collecting 12 months of IT energy in order to receive a rating.

If the UPS system supports non-IT loads that amount to more than 10% of its load (e.g., cooling equipment), this load can be sub-metered (see “B” in figure below). When entering “Annual IT Energy” numbers in Portfolio Manager, users will need to subtract the sub-metered energy from the UPS output meter. The difference is the energy used for IT equipment, which is entered into Portfolio Manager.

There are two exceptions to the UPS output requirement: first, if there no UPS system; and second, if the UPS system supports non-IT loads that amount to more than 10% of its load (e.g., cooling equipment) and cannot be sub-metered. In both of these cases, you should provide the IT energy consumption measured at the input to the Power Distribution Unit (PDU) (see “C” in figure below).

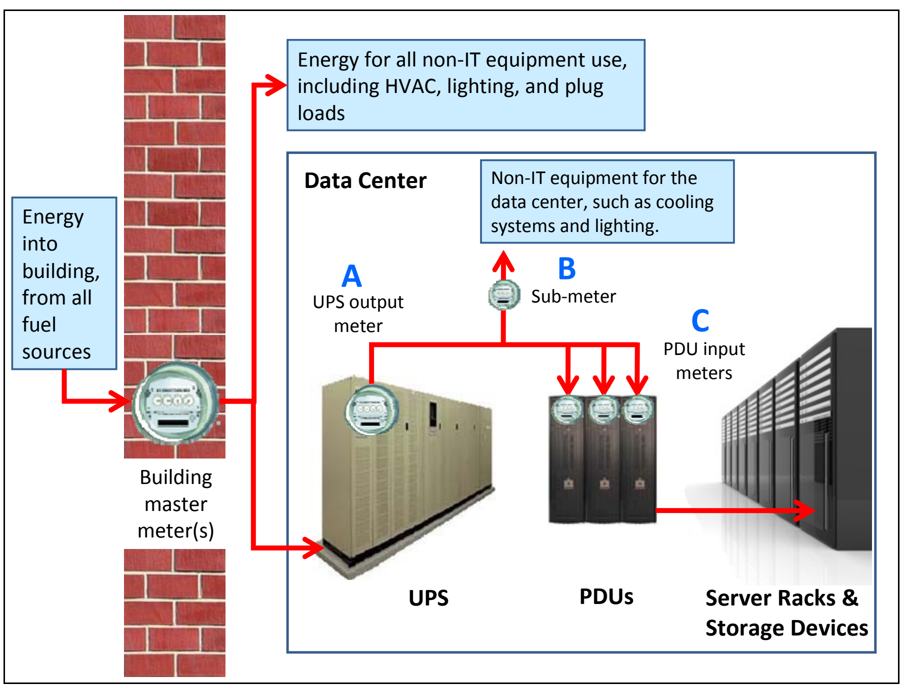


Figure 1 – Measuring IT Energy Consumption

The data center space located within my office building is already sub-metered (either for direct billing from the utility or so that the landlord can bill back the tenant for its energy use). Can we use this information to enter "IT Energy Consumption" for the data center when benchmarking in Portfolio Manager?

No. If the data center in your office building has already been sub-metered by the utility or landlord, then the energy consumption being tracked through the main meters to the building will reflect the total energy consumed within that space – including lighting and space conditioning. While this is very useful information to have, as it helps to identify the contribution of the data center space to overall building energy consumption, it does not meet Portfolio Manager's definition of "IT Energy Consumption."

When using Portfolio Manager to benchmark a stand alone data center, or a mixed use facility that contains a "data center," you must be able to measure, track, and input the specific amount of energy delivered directly to IT equipment (servers, storage devices, etc.). For this reason, measurements must be obtained at the output of the Uninterruptable Power Supply (UPS) or, in some cases, the input of the Power Distribution Unit (PDU). Measurement at the output of the UPS or input of the PDU is commonplace in the industry and is consistent with how the data was collected for development of the Data Center energy performance score. For more information, see the FAQ, "Where should I measure the IT energy consumption to get a Data Center rating?"

Many UPS systems already include meters that are capable of measuring electricity consumption (kWh). However, some UPS systems do not have integrated meters, or else only track demand (kW). In cases where there is no UPS meter, or where the UPS meter is only tracking kW, it will be necessary to install a new meter to begin isolating and tracking IT energy consumption (kWh) on a monthly basis. If the UPS meter is already tracking consumption but the UPS system supports non-IT equipment (e.g., cooling, lighting) that amounts to more than 10% of its load, then this supplemental load must be sub-metered and subtracted from the "IT Energy" numbers that are entered into Portfolio Manager.

A number of vendors provide simple, cost-effective sub-metering technologies that can be installed without any system downtime. These can usually be installed by the vendor or any professional electrician, and some can be linked to the building's EMS for remote monitoring. For the purpose of benchmarking in Portfolio Manager, the preferred location for installing such a sub-meter is at the output of the UPS.

PLEASE NOTE: there is no requirement to sub-meter your entire data center space – only the "IT Energy Consumption" within that space needs to be sub-metered so that IT equipment consumption (kwh) can be accounted for properly. The total energy consumption of your building, including the data center non-IT loads, will be captured when you enter your whole-building consumption information into the "Energy Meters" section of Portfolio Manager, on the "Facility Summary" page. Furthermore, by entering your IT energy, you are not double-counting your data center energy consumption. The "IT Energy Consumption" input is used for normalization purposes within the data center energy performance score. It can be thought of as being analogous to other operational characteristics in the office model like "number of workers" or "operating hours per week."

Can I enter power readings for the annual IT energy consumption if my UPS or PDU meter only provides power readings (kW)?

No. Portfolio Manager requires energy consumption (kWh) readings.

The ENERGY STAR score is designed to evaluate the total annual energy use of a building. The whole building metrics used in Portfolio Manager measure total energy use over the course of a year, in order to account for differences in fuel types utilized, interactions among energy-using systems within a building, and the efficiency of buildings at both peak and non-peak times. These effects cannot be captured by one-time power readings.

Many UPS meters can be configured to record energy consumption, reading cumulative total energy, which can be assessed at the end of each month. If your equipment does not have these settings, you will need to install an energy meter.

Why can't I measure my Data Center IT load closer to the actual IT equipment, like at the PDU output or at individual servers?

EPA's rating methodology is based on a statistical analysis of a data set in which IT energy was measured at the UPS output. In order to receive the most accurate rating on this scale, it is necessary to take measurements at the same location. For this reason, EPA requires measurements at the UPS output. Measurements at the PDU output or on the servers are not permitted and will not improve your rating.

However, meters located at the PDU output, or on the servers directly, may be extremely valuable for your organization. These allow for a more advanced calculation of PUE which can help you measure and improve efficiency of power distribution at your facility. Therefore EPA encourages you to install this type of meter at your facility. At the time of EPA's study, PDU and server metering were not commonplace and therefore could not be analyzed. However, EPA has identified this as a future area of research.

Can I get a rating that applies just to a Data Center located within a building?

No. The energy performance ratings are designed to assess whole building energy consumption. If you have a larger commercial building (e.g., Office) that contains a Data Center, you should enter the entire building. Within Portfolio Manager you should enter two spaces: Office and Data Center. Enter the appropriate data in the required fields for each space, and then enter your total building energy consumption. Portfolio Manager will provide a single rating for the building.

ENERGY STAR® Performance Ratings
Technical Methodology for Data Center

This document presents specific details on the EPA's analytical result and rating methodology for Data Center. For background on the technical approach to development of the energy performance ratings, refer to *Energy Performance Ratings – Technical Methodology* (http://www.energystar.gov/ia/business/evaluate_performance/General_Overview_tech_methodology.pdf).

Model Release Date

June 2010

Portfolio Manager Definition

Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data Center functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities. Often Data Centers are free standing, mission critical computing centers. When a data center is located within a larger building, it will usually have its own power and cooling systems. The Data Center space is intended for sophisticated computing and server functions; it should not be used to represent a server closet or computer training area.

Reference Data

The Data Center regression model is based on survey data collected by EPA. EPA relies on publicly available external data sets to develop rating models where feasible, but a sufficiently robust set of data center energy consumption information was not available. In its effort to collect survey data, EPA coordinated with major industry associations, including Uptime Institute, Green Grid, 7x24 Exchange, and AFCOM, to inform their members and encourage participation.

EPA collected data from stand alone data center facilities as well as those enclosed within larger buildings. In addition to collecting energy consumption data, EPA consulted with industry associations and partners to determine the specific operating parameters that were likely to influence energy consumption, and developed a list of operating characteristics that were requested from survey participants.

Data Filters

Four types of filters are applied to define the peer group for comparison and to overcome any technical limitations in the data: Building Type Filters, EPA Program Filters, Data Limitation Filters, and Analytical Filters. A complete description of each of these categories is provided in Section V of the general technical description document: *Energy Performance Ratings –*

Technical Methodology. **Table 1** presents a summary of each filter applied in the development of the Data Center model, the rationale behind the filter, and the resulting number of observations after the filter is applied. After all filters are applied, the remaining data set has 61 observations.

Table 1
Summary of Data Center Model Filters

Condition for Including an Observation in the Analysis	Rationale	Number Remaining
Must have complete data for energy use and operating characteristics	EPA Program Filter - Complete data is necessary for analysis.	120
Must provide IT Energy measured at the output of the UPS Meter	EPA Program Filter – In order to develop an equitable comparison between facilities, all IT Energy consumption must be measured at the same location.	108
Must be a Stand Alone data center	Analytical Filter – Data for Stand Alone data centers was more robust and resulted in higher significance for regression models. Using stand alone facilities is also more consistent with the process used by EPA for other space types.	61

Dependent Variable

The dependent variable in the Data Center analysis is Power Usage Effectiveness, or PUE. This variable is unique to the Data Center space type. Source energy use intensity (source EUI) is used for the majority of EPA's rating models, but was not considered to be the best choice for a Data Center model. Source EUI can vary widely for data center facilities, and does not take into consideration the varying densities of IT equipment that can be present in these facilities.

EPA consulted with industry associations and data center operators to identify an appropriate metric to evaluate energy use in data center facilities. The dependent variable of PUE is defined as:

$$\text{PUE} = \text{Total Energy} / \text{IT Energy}$$

where both Total Energy and IT Energy are expressed in Source kBtu.

Total Energy includes the annual energy consumption for all fuels at the Data Center. In many cases, the only energy consumption at Data Centers is electricity. However, it is important to capture any other fuel use (e.g. chilled water, natural gas), in order to evaluate the total energy performance of the facility. This practice is consistent with all EPA rating models.

IT Energy is defined as the total amount of energy required by the server racks, storage silos, and other IT equipment in the Data Center. For the purposes of ENERGY STAR, this should be measured at the output of the Uninterruptible Power Supply (UPS).

EPA considered alternate locations for measuring IT Energy consumption, and requested data from both the UPS and PDU meters from survey participants. Measurements at the PDU meter or closer to the racks can provide a more accurate representation of IT Energy. However, these measurements are still not commonplace in the industry, and were not provided by a large number of survey participants. EPA prefers a common metric that can be used by the majority of Data Center operators.

By setting PUE as the dependent variable, the regressions analyze the key drivers of PUE – those factors that explain the variation in Power Usage Effectiveness in Data Centers.

Independent Variables

The EPA survey contained numerous building operation questions that were identified as potentially important for Data Centers. Based on a review of the available variables in the data, in accordance with the EPA criteria for inclusion[1], EPA analyzed the following variables:

- Building Square Footage
- Data Center Square Footage
- Tier Level (four levels denoting increasing equipment redundant capacity)
- Number of racks
- UPS Utilization
- Annual IT Energy
- Building Type (Stand alone data center vs. Enclosed in another building)
- Data Center type (options included Hosting, Hybrid, Internet, Traditional, and Telecom)
- HDD
- CDD

EPA performed extensive review on all of these operational characteristics. In addition to reviewing each characteristic individually, characteristics were reviewed in combination with each other (e.g., IT Energy / Square Foot). Based on analytical results and residual plots, variables were examined using different transformations (such as the natural logarithm). The analysis consisted of multiple regression formulations. These analyses were structured to find the combination of statistically significant operating characteristics that explained the greatest amount of variance in the dependent variable: PUE.

Based on the Data Center regression analysis, the following characteristic was identified as the key explanatory variable that can be used to estimate the expected average PUE in Data Centers:

- Annual IT Energy

[1] For a complete explanation of these criteria, refer to *Energy Performance Ratings – Technical Methodology* (http://www.energystar.gov/ia/business/evaluate_performance/General_Overview_tech_methodology.pdf).

IT Energy Analysis
The Annual IT Energy variable warrants additional discussion, because it is unlike most operating characteristics included in EPA's rating models. Most variables can be entered as a single value that remains relatively constant throughout the year (i.e. Square Foot, Hours of Operation). IT Energy, on the other hand, must be metered on a regular basis. Users can enter monthly entries in Portfolio Manager. The total use over a period of one year is calculated and used in the regression equation.

The regression analysis shows that facilities with higher IT Energy loads have lower PUE values on average. This phenomenon can be understood as an economy of scale: the larger, more intensive data centers can have more opportunities for efficiencies than their smaller counterparts. Similar behavior has been observed in other types of commercial buildings, where larger buildings may use less energy per square foot. The relationship between PUE and Annual IT Energy was only observed up to a certain Annual IT Energy value, after which the average PUE values level off (i.e. there are no longer economies of scale beyond a certain size). Therefore, the adjustment of IT Energy within the model is applied over that range, and capped at a maximum adjustment at the value of 0.4 Source TBtu. That is, Data Centers with IT energy values of greater than 0.4 TBtu will receive the same regression adjustment as Data Centers with IT energy equal to 0.4 TBtu.

Model Testing and Variables not Correlated with PUE
The Data Center rating model includes fewer operating characteristics than most EPA rating models. It was determined that the Annual IT Energy is the primary factor influencing PUE, and that other operating characteristics do not show any statistically significant correlation with PUE.

Climate is one characteristic that was examined closely. EPA found no statistically significant relationship between heating and cooling degree days and PUE, which was initially considered to be surprising. However, upon further review, it was determined that the energy required for cooling a data center is dominated by the high internal loads generated by the IT equipment, and that climate has a relatively low contribution to the building cooling load.

EPA also examined Tier level, a measure of redundancy of equipment capacity, and Data Center type, with options that included Hosting, Hybrid, Internet, Traditional, and Telecom. These characteristics were both excluded from the final Data Center model. The dependence of PUE on both variables was not shown to be statistically significant. Additionally, the variables were determined to be hard to define. Operators reported that there could be multiple Tiers or Data Center types within one facility. For Tier, it was also determined that data centers may have unnecessarily high Tier levels, and normalization for Tier could provide a disincentive for efficient design.

Regression Modeling Results
The final regression is a weighted ordinary least squares regression across the data set of 61 observations. The dependent variable is PUE. The independent variable is centered relative to the mean value, presented in **Table 2**. The final model is presented in **Table 3**. The model variable

is significant at the 95% confidence level or better, as shown by the significance level (a p-level of less than 0.05 indicates 95% confidence).

The model has an adjusted R^2 value of 0.0988, indicating that this model explains 9.88% of the variance in PUE for Data Center facilities. Because the final model is structured with PUE as the dependent variable, the explanatory power of IT Energy is not included in the R^2 value, thus this value appears artificially low. Re-computing the R^2 value in units of source energy[2], demonstrates that the model actually explains 92.2% of the variation of source energy of Data Centers. This is an excellent result for a statistically based energy model.

Detailed information on the ordinary least squares regression approach, the methodology for performing weather adjustments, and the independent variable centering technique is available in the technical document: *Energy Performance Ratings – Technical Methodology*.

Table 2
Descriptive Statistics for Variables in Final Regression Model

Variable	Full Name	Mean	Minimum	Maximum
PUE	Power Usage Effectiveness	1.924	1.362	3.598
Annual IT Energy	Annual IT Energy (in Source TBtu)	0.2091	0.0129	0.7204

Table 3
Final Regression Modeling Results

Dependent Variable		Power Usage Effectiveness (PUE)		
Number of Observations in Analysis		61		
Model Adjusted R^2 value		0.0988		
Model F Statistic		7.579		
Model Significance (p-level)		0.0078		
	Unstandardized Coefficients	**Standard Error**	**T value**	**Significance (p-level)**
(Constant)	1.924	0.0523	36.81	0.0000
C_Annual IT Energy	-0.9506	0.3453	-2.753	0.0078

Note:
- The prefix C_ on Annual IT Energy indicates that the value is centered. The centered variable is equal to difference between the actual value and the observed mean. The observed mean Annual IT Energy is 0.2091 Source TBtu.
- Annual IT Energy is computed in Source Energy, and entered in Tera Btu (TBtu):
Annual IT Energy kWh(3.412kBtu/kWh)*(3.34 Source/Site Electric)*(1 TBtu/10^9kBtu)*
- The Annual IT Energy adjustment is capped at 0.4 TBtu

[2] The R^2 value in Source Energy is calculated as: 1 – (Residual Variation of Y) / (Total Variation of Y). The residual variation is sum of (Actual Source Energy_i – Predicted Source Energy_i)^2 across all observations. The Total variation of Y is the sum of (Actual Source Energy_i – Mean Source Energy)^2 across all observations.

Data Center Lookup Table

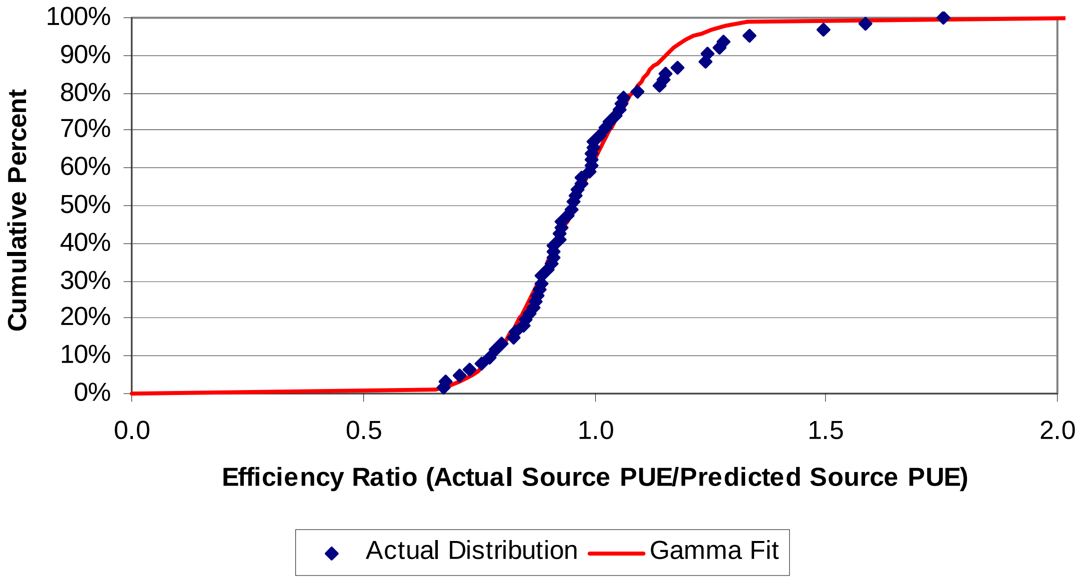
The final regression model (presented in **Table 3**) yields a prediction of PUE based on a building's Annual IT Energy. Some buildings in the data sample use more energy than predicted by the regression equation, while others use less. The *actual* PUE of each building observation is divided by its *predicted* PUE to calculate an energy efficiency ratio:

Energy Efficiency Ratio = Actual PUE/ Predicted PUE

A lower efficiency ratio indicates that a building uses less energy than predicted, and consequently is more efficient. A higher efficiency ratio indicates the opposite.

The efficiency ratios are sorted from smallest to largest and the cumulative percent of the population at each ratio is computed using the individual observation weights from the dataset. Figure 1 presents a plot of this cumulative distribution. A smooth curve (shown in red) is fitted to the data using a two parameter gamma distribution. The fit is performed in order to minimize the sum of squared differences between each building's actual percent rank in the population and each building's percent rank with the gamma solution. The final fit for the gamma curve yielded a shape parameter (alpha) of 43.93 and a scale parameter (beta) of 0.0219. For this fit, the sum of the squared error is 0.0555.

Figure 1:
Data Center Distribution



The final gamma shape and scale parameters are then used to calculate the efficiency ratio at each percentile (1 to 100) along the curve. For example, the ratio on the gamma curve at 1% corresponds to a rating of 99; only 1% of the population has a ratio this small or smaller. The ratio on the gamma curve at the value of 25% will correspond to the ratio for a rating of 75; only 25% of the population has ratios this small or smaller. The complete lookup table is presented at the end of the document. In order to read this lookup table, note that if the ratio is less than 0.6569 the rating for that building should be 100. If the ratio is greater than or equal to 0.6569 and less than 0.6879 the rating for the building should be 99, etc.

Example Calculation

As detailed in the document *Energy Performance Ratings – Technical Methodology*, there are five steps to compute a rating. The following is a specific example with the Data Center model:

<u>Step 1 – User enters building data into Portfolio Manager</u>

For the purposes of this example, sample data is provided.

- Energy data
  - Total annual electricity = 15,000,000 kWh
  - Total annual natural gas = 20,000 therms
  - Note that this data is actually entered in monthly meter entries
- Operational data
  - Annual IT Energy = 8,500,000 kWh

<u>Step 2 – Portfolio Manager computes the Actual Power Usage Effectiveness</u>

In order to compute the actual PUE, Portfolio Manager must convert each fuel from the specified units (e.g. kWh) into Site kBtu, and must convert from Site kBtu to Source kBtu.

- Convert the meter data entries into site kBtu
  - Electricity: (15,000,000 kWh)*(3.412kBtu/kWh) = 51,180,000 kBtu Site
  - Natural gas: (20,000 therms)*(100kBtu/therm) = 2,000,000 kBtu Site
- Apply the source-site ratios to compute the source energy
  - Electricity:
    51,180,000 SitekBtu*(3.34 Source kBtu/Site kBtu) = 170,941,200 kBtu Source
  - Natural Gas:
    2,000,000 Site kBtu*(1.047 Source kBtu/Site kBtu) = 2,094,000 kBtu Source
- Combine source kBtu across all fuels
  - 170,941,200 kBtu + 2,094,000 kBtu = 173,035,200 kBtu Source

Portfolio Manager must also convert Annual IT energy (kWh) into Site kBtu, and then from Site kBtu to Source kBtu.

- Convert the Annual IT Energy into site kBtu
  - (8,500,000 kWh)*(3.412kBtu/kWh) = 29,002,000 kBtu Site
- Apply the source-site ratios to compute the source energy
  - 29,002,000 Site kBtu *(3.34 Source kBtu/Site kBtu) = 96,866,680 kBtu Source

Then, Portfolio Manager calculates the actual PUE.

- Divide total source energy by Annual IT Energy to get the Actual PUE
  - PUE = 173,035,200 kBtu / 96,866,680 kBtu = 1.786

Step 3 – Portfolio Manager computes the Predicted Power Usage Effectiveness

Portfolio Manager uses the building data entered under Step 1 to compute centered values for each operating parameter. The centered value is entered into the Data Center regression equation to obtain a predicted PUE.

- Calculate centered variables
    - Subtract the reference centering IT Energy value from the measured value
        - Annual IT Energy = 96,866,680 kBtu /(10^9 TBtu/kBtu) = 0.0969 TBtu
        - Annual IT Energy - 0.2091 = 0.0969 - 0.2091 = -0.1122
- Compute predicted PUE using the regression equation:
    - PUE = 1.924 – 0.9506 * (Centered Source TBtu)
    - PUE = 1.924 – 0.9506 *(-0.112) = 2.031

Step 4 – Portfolio Manager computes the energy efficiency ratio

The energy efficiency ratio is equal to: Actual PUE/ Predicted PUE

- Ratio = 1.786/2.031 = 0.8795

Step 5 – Portfolio Manager looks up the efficiency ratio in the lookup table

Starting at 100 and working down, Portfolio Manager searches the lookup table for the first ratio value that is larger than the computed ratio for the building.

- A ratio of 0.8795 is greater than 0.8770 (requirement for 71) but less than 0.8810 (requirement for 70)
- ***The rating is 71***

Attachment

Table 4 lists the energy efficiency ratio cut-off point for each rating, from 1 to 100.

Table 4

Lookup Table for Data Center

Rating	Cumulative Percent	Energy Efficiency Ratio		Rating	Cumulative Percent	Energy Efficiency Ratio	
		> =	<			> =	<
100	0%	0.0000	0.6569	50	50%	0.9548	0.9584
99	1%	0.6569	0.6879	49	51%	0.9584	0.9620
98	2%	0.6879	0.7082	48	52%	0.9620	0.9657
97	3%	0.7082	0.7236	47	53%	0.9657	0.9694
96	4%	0.7236	0.7364	46	54%	0.9694	0.9731
95	5%	0.7364	0.7474	45	55%	0.9731	0.9768
94	6%	0.7474	0.7571	44	56%	0.9768	0.9805
93	7%	0.7571	0.7659	43	57%	0.9805	0.9843
92	8%	0.7659	0.7739	42	58%	0.9843	0.9880
91	9%	0.7739	0.7814	41	59%	0.9880	0.9919
90	10%	0.7814	0.7883	40	60%	0.9919	0.9957
89	11%	0.7883	0.7949	39	61%	0.9957	0.9996
88	12%	0.7949	0.8011	38	62%	0.9996	1.0035
87	13%	0.8011	0.8071	37	63%	1.0035	1.0075
86	14%	0.8071	0.8127	36	64%	1.0075	1.0115
85	15%	0.8127	0.8182	35	65%	1.0115	1.0156
84	16%	0.8182	0.8235	34	66%	1.0156	1.0198
83	17%	0.8235	0.8285	33	67%	1.0198	1.0240
82	18%	0.8285	0.8335	32	68%	1.0240	1.0282
81	19%	0.8335	0.8383	31	69%	1.0282	1.0326
80	20%	0.8383	0.8429	30	70%	1.0326	1.0370
79	21%	0.8429	0.8475	29	71%	1.0370	1.0415
78	22%	0.8475	0.8520	28	72%	1.0415	1.0461
77	23%	0.8520	0.8563	27	73%	1.0461	1.0508
76	24%	0.8563	0.8606	26	74%	1.0508	1.0556
75	25%	0.8606	0.8648	25	75%	1.0556	1.0605
74	26%	0.8648	0.8689	24	76%	1.0605	1.0656
73	27%	0.8689	0.8730	23	77%	1.0656	1.0708
72	28%	0.8730	0.8770	22	78%	1.0708	1.0761
71	29%	0.8770	0.8810	21	79%	1.0761	1.0816
70	30%	0.8810	0.8849	20	80%	1.0816	1.0873
69	31%	0.8849	0.8888	19	81%	1.0873	1.0932
68	32%	0.8888	0.8926	18	82%	1.0932	1.0994
67	33%	0.8926	0.8964	17	83%	1.0994	1.1058
66	34%	0.8964	0.9002	16	84%	1.1058	1.1125
65	35%	0.9002	0.9039	15	85%	1.1125	1.1195
64	36%	0.9039	0.9076	14	86%	1.1195	1.1269
63	37%	0.9076	0.9113	13	87%	1.1269	1.1348
62	38%	0.9113	0.9150	12	88%	1.1348	1.1432
61	39%	0.9150	0.9186	11	89%	1.1432	1.1521
60	40%	0.9186	0.9223	10	90%	1.1521	1.1619
59	41%	0.9223	0.9259	9	91%	1.1619	1.1725
58	42%	0.9259	0.9295	8	92%	1.1725	1.1842
57	43%	0.9295	0.9331	7	93%	1.1842	1.1974
56	44%	0.9331	0.9367	6	94%	1.1974	1.2126
55	45%	0.9367	0.9403	5	95%	1.2126	1.2306
54	46%	0.9403	0.9439	4	96%	1.2306	1.2530
53	47%	0.9439	0.9475	3	97%	1.2530	1.2831
52	48%	0.9475	0.9512	2	98%	1.2831	1.3315
51	49%	0.9512	0.9548	1	99%	1.3315	>1.3315